New Scientist

WEEKLY 30 October 2021

COP26 CLIMATE SUMMIT

The key issues and players

Countries' emissions gaps

Ed Miliband interview: How not to screw things up

COVID SPREAD

How much do vaccines reduce transmission?

THE VEGAN HEALTH TRAP

The hidden perils of plant-based substitute foods

BLIGHTED SKIES

Is space junk making astronomy impossible?

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This week's issue

On the cover

38 The vegan health trap
The hidden perils of plant-based substitute foods

42 Blighted skies
Is space junk making astronomy impossible?

Vol 252 No 3358
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COP26 climate summit
8 The key issues and players
10 Countries' emissions gaps
12 Ed Miliband interview: How not to screw things up

19 Covid spread
How much do vaccines reduce transmission?

34 Kim Stanley Robinson interview
24 Brain in a dish
54 Do magnets affect our cells?
24 World's oldest crab

47 Features

> **"Business as usual won't be broken without the threat of significant mass unrest"**

News

13 Male fertility
Frozen testes tissue could soon be reimplanted

16 Cryptocurrency chaos
Rocky start for El Salvador's bitcoin experiment

19 Dim supernova
Barely-there star explosion leaves astronomers puzzled

Views

27 Comment
Don't overlook grasslands in the fight against climate change, says Gill Perkins

28 The columnist
Annalee Newitz dives into the secrets of the streaming giants

30 Aperture
When art and climate collide

32 Letters
Don't let the RNA medical revolution get derailed

35 Culture
What *Frankenstein* tells us about the science of life

LUDOVIC ORLANDO/NATURAL HISTORY MUSEUM OF DENMARK/AMIS/CNRS PHOTOTHÈQUE

18 Faithful steed When were horses first domesticated?

Features

38 Vegan meats
You might be surprised at what you will find in plant-based food

42 Space jam
How a proliferation of satellites is affecting our skies, and what can be done about it

47 Andreas Malm interview
Climate activist and human ecologist says we need more than peaceful protests

The back pages

52 Stargazing at home
How to find Canis Major and Canis Minor using Orion

53 Puzzles
Try our crossword, quick quiz and logic puzzle

54 *Almost* the last word
Is it normal for rooks to bury bread instead of eating it?

55 Tom Gauld for *New Scientist*
A cartoonist's take on the world

56 Feedback
Why researchers are making honeybees crash into walls

Elsewhere on New Scientist

Virtual event

A prehistory of Britain in seven burials

The study of genomes has been revolutionising our knowledge of our deep past. In this talk, anthropologist Alice Roberts will delve into seven burials to help tell the story of British prehistory, from the Palaeolithic to the Iron Age. Join us on 4 November at 6pm GMT (1pm EST) or watch on demand. Tickets available now.

newscientist.com/events

Online

Covid daily update

Stay on top of all the most crucial developments in the pandemic with our briefing, updated at 12pm GMT every weekday. We round up the latest coronavirus news, and give links to exclusive features and interviews.

newscientist.com/ coronavirus-latest

Podcast

Weekly

We begin with news of a treatment that provides hope for children who are born with no immune system. Ecosystem researcher Yadvinder Malhi talks through the science of the new film *Dune*, an adaption of Frank Herbert's epic novel. The team also discuss how hard Iran has been hit by the covid-19 pandemic, plus we hear about the world's largest artificial intelligence and details of a soundtrack for the COP26 climate summit.

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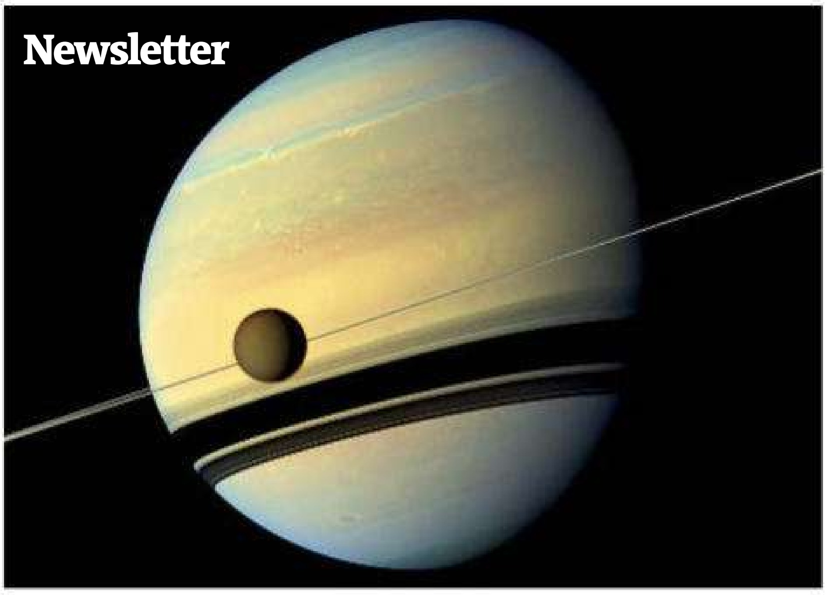


NASA/JPL-CALTECH/SPACE SCIENCE INSTITUTE

Runaway moon Saturn's moon Titan is moving away from the planet

CHIA BELLA JAMES/WARNER BROS. ENTERTAINMENT INC.

Science of *Dune* The new film is based on a futuristic 1965 novel

Video

Wooden knives

Watch a wooden knife that is three times sharper than steel cut through steak over on our YouTube channel. The knife, which was made by soaking cellulose fibres in a solution and then boiling the mix, is 23 times harder than raw wood. For the latest videos from the world of science and technology, subscribe to our channel.

youtube.com/newscientist

Newsletter

Launchpad

Sign up for reporter Leah Crane's wonderful newsletter on space science. In the latest edition, Leah explains why Saturn's moon Titan is in trouble. The moon is moving away from its planet at a rate of 11 centimetres per year. Along with other factors, this could cause Titan to eventually be tossed out from its planet.

newscientist.com/ launchpad

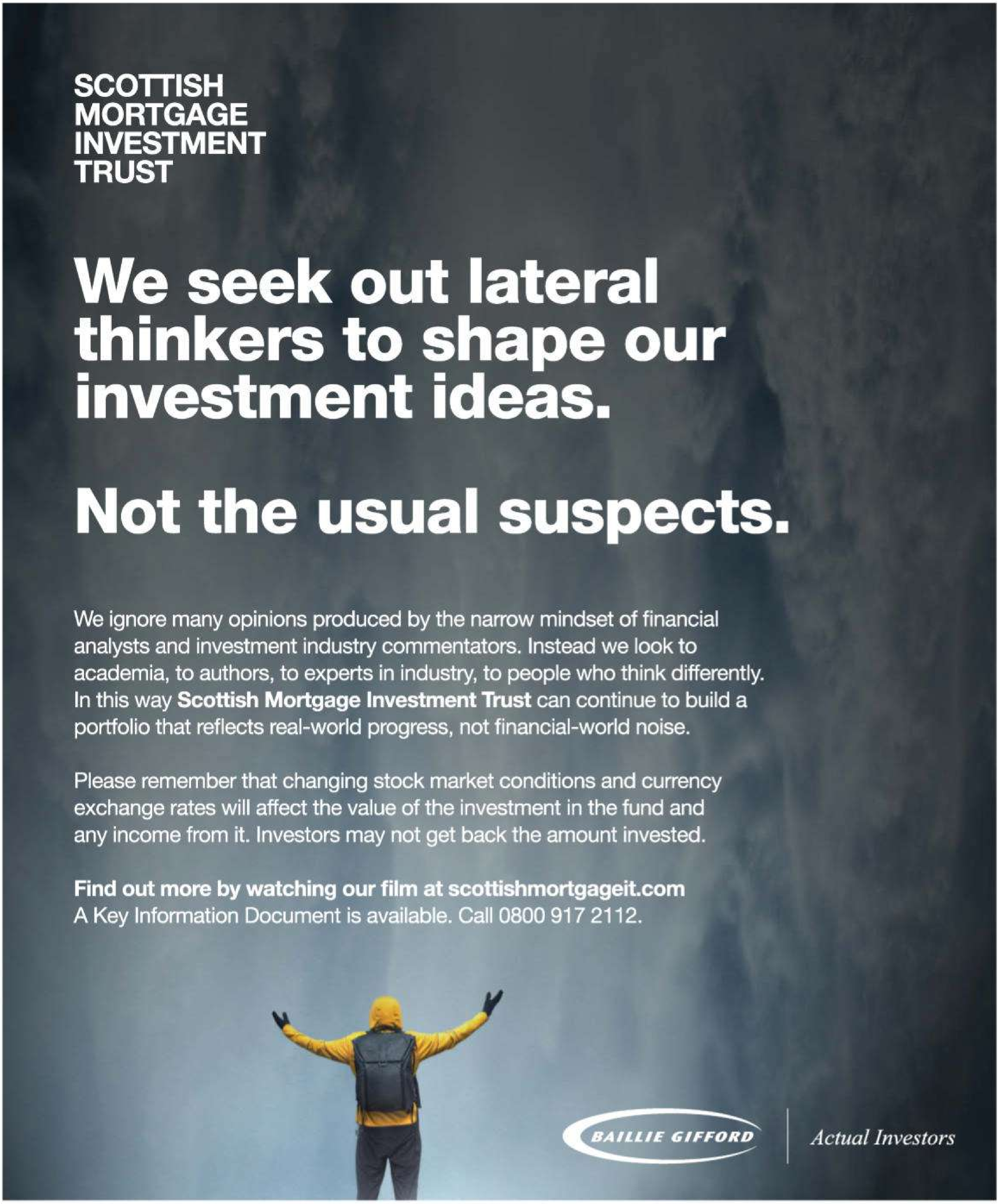
Newsletter

> **"Titan will probably be either tossed out of the system or fall towards Saturn"**

Calendar 2022

Our calendar showcases a year of fantastic science photography, with all shortlisted entries from our 2021 Photography Awards. It has all UK bank holidays along with key dates in the scientific calendar. It is perfect to help you stay organised in 2022.

shop.newscientist.com/ calendar



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Save our skies

Space junk requires a response like climate change – only quicker

ALL eyes are on the COP26 climate summit, which starts in Glasgow, UK, on Sunday. But amid the "anarchy", in the words of former UK climate minister Ed Miliband, of the hot phase of negotiations (page 12), in quieter moments, we might cast our thoughts to a problem fast brewing further skywards.

In mid 2019, there were 2000 satellites in orbit. That number has now doubled in two years, spurred on by the ambitions of private communications companies. A third of all satellites belong to just one swarm: Starlink, operated by SpaceX.

Satellites aren't bad per se, of course. They are vital to scientific research, providing data on everything from the effects of climate change to the movements of pirate ships. A laudable aim of Starlink is to bring internet access to communities that wouldn't otherwise have it.

But the attitude of many companies and institutions involved seems to be a laissez-faire assurance we can continue pumping as much stuff into orbit as we like with no consequences. Warnings from scientists about the repercussions have been met largely with indifference.

Those warnings come in two forms.

> "So far, the attitude has been that we can pump as much as we like into orbit with no consequences"

First, for astronomy, as our clear view of the night sky becomes impeded by thousands of tonnes of often highly reflective space metal. Second, for the satellites themselves and potentially for human life and limb, due to the increasing amounts of space junk (discarded satellites and bits that have fallen off) careering around.

On that second point – the parallels with climate change continue to reverberate – we may already be too late to stop bad things happening. Minor perturbations in orbits that could lead to major collisions build up only slowly, and may already have begun. A further irony is that a warming planet might exacerbate the problem by reducing the drag on satellites, keeping them in orbit for longer (see page 42).

Solving the problem means taking a leaf out of the COP book. The world needs to take space junk seriously and establish an international mechanism to solve the problem in the interests of all the parties involved – and in a more timely manner than we ever did with climate change. ▮

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AN IMPORTANT MESSAGE FROM PROFESSOR NICK LEMOINE MD PHD FMEDSCI, CHAIR OF THE MEDICAL RESEARCH FOUNDATION

Gifts in Wills could be the key to protecting the future of human health

Our experience of COVID-19 shows how suddenly a global health challenge can appear. As someone interested in science, you will understand that while nobody can predict what we will face next, we can be certain that the future will bring many more threats to human health.

As Chair of the Medical Research Foundation – the charitable arm of the Medical Research Council – I have seen the incredible impact that individuals who remember the Foundation in their Wills can have on the future of our health and wellbeing here in the UK. These gifts fund research and researchers which can have far-reaching implications for human health.

With a gift in your Will you can play a key role in providing the science that will protect the health of future generations.

Right now, the Foundation is funding research to tackle antimicrobial resistance, and investing in researchers like Dr Myrsini Kaforou – who will make the fight against antimicrobial resistance her life's work.

Without support at the crucial early stages, researchers like Dr Kaforou can be forced to abandon their passion and leave science altogether, with an immeasurable loss to future human health. Gifts in Wills provide the long term funding and security that allows the Foundation to invest in projects like Dr Kaforou's and lay the foundations for quality research in years to come.

Your Will can fund the rational response to health challenges that medical science provides.

> "As scientists, our duty is to secure the future of research for the generations that follow."
>
> Professor Fiona Watt, President of the Medical Research Foundation and Executive Chair of the Medical Research Council.

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Changing lives tomorrow.
medicalresearchfoundation.org.uk

"The funding I received through the Medical Research Foundation will be transformative for my research." Dr Myrsini Kaforou

While we don't know what the future holds for human health in the UK, we do know that research, and the brilliant scientists driving that research forward, are the key to meeting those challenges for years to come.

But many of these scientists rely on the generosity and foresight of fellow members of the public – people like you, who understand the power of science and are willing to leave a gift to medical research in their Wills. At the Medical Research Foundation, over 90% of our voluntary income comes from individuals who choose to include a gift in their Will – they are crucial in the Foundation's ability to fund research that will enable the next generation of scientists to make real world discoveries in the future.

I firmly believe that a gift in your Will to the Medical Research Foundation is an excellent investment and will have a lasting impact on science and on the future of human health in the UK.

Please consider this very special gift today.

Professor Nick Lemoine MD PhD FMedSci
Chair of the Medical Research Foundation

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Explorable video A few photos can generate a 3D scene p13

Bye bye Titan Saturn's moon could fly away as the planet tilts p16

Strike a pose AI can change a fashion model's clothes p18

Tiny mind Brain-in-a-dish kept alive for almost a year p24

Green cutlery Wooden knife sharper than steel cuts steak p25

ANDY RAIN/EPA-EFE/SHUTTERSTOCK

A coronavirus testing centre in London, UK

Coronavirus

Concern as UK cases rise

The UK government is being warned that England is on track for another difficult winter, reports **Sam Wong**

THE number of coronavirus cases in the UK has risen to its highest level since July, and hospitalisations and deaths are also rising despite relatively high vaccination rates. Yet the UK government has said it has no immediate plans to change current policy in England despite mounting pressure from health bodies to implement tougher measures sooner rather than later.

In the week to 25 October, 315,698 confirmed cases and 942 deaths were recorded in the UK, both figures roughly 10 per cent higher than the previous week. The number of daily cases is now on a par with the large spike seen in July after most lockdown measures were lifted.

Senior figures in the National Health Service and the British Medical Association have urged the government to implement "Plan B" of the winter coronavirus strategy in England, a set of measures including vaccine passports, mandatory face coverings and guidance to work from home.

Sajid Javid, the UK health secretary, rejected the calls and instead encouraged individuals to "do their bit" by getting vaccinated, getting tested regularly and thinking about hand hygiene.

"We don't think we have reached the point where Plan B needs to be activated, but, of course, we will keep it under review," Javid said on BBC Radio 4 on 25 October.

The UK's incidence of 478 cases per 100,000 population in the past seven days is many times higher than in other western European countries such as France (55), Germany (114), Spain (12) and Italy (39). Some models project cases will fall even without Plan B.

> "We don't think we have reached the point where Plan B needs to be activated"

Almost 80 per cent of the UK population is fully vaccinated, but most children aren't and infections among this group are thought to be driving the spread.

"It's very clear that, with the delta variant, schools are certainly contributing substantially to spread," says Deepti Gurdasani at Queen Mary University of London. Other countries in western Europe, such as France, are keeping cases lower, despite their lower rates of vaccination uptake, thanks to strong mitigation policies such as mandatory mask wearing in schools, she says.

The latest results from the UK's Office for National Statistics infection survey, for the week ending 16 October, suggest that 1 in 55 people in England are infected, and 1 in 45 in Wales. The highest rates are in children aged between 11 and 16, with 7.8 per cent of this group testing positive.

Vaccinations started being rolled out to UK children aged between 12 and 15 on 20 September, but just 18.9 per cent of this group had received a jab in England by 22 October. They have been mostly delivered in schools, but NHS England is now allowing parents to make appointments for children at vaccine centres. Javid has also said he is considering making vaccines compulsory for NHS workers in England.

Vaccine passports, masks and more attention to ventilation have helped to keep numbers low in other European countries, and should be put in place now in the UK, says Gurdasani. "I worry that if we don't take those steps now, we will be heading towards much harsher restrictions when the NHS once again gets completely overwhelmed, and it's very near there now even ahead of winter," she says. ■

The summit

What to expect at COP26

Over the next five pages, **Adam Vaughan** explains everything you need to know about one of the most significant climate summits ever, starting with the topics on the table at the meeting

JEFF J MITCHELL/GETTY IMAGES

The Scottish Event Campus in Glasgow, UK, where COP26 will take place

THE United Nations COP26 climate summit, which runs from 31 October to 12 November in Glasgow, UK, has been described as a "turning point for humanity" and "the most consequential summit... ever".

Delayed due to the covid-19 pandemic, the meeting is by far the most important gathering on climate change since nearly 200 countries adopted the Paris Agreement in 2015. Where the Paris meeting's job was to forge a new global treaty on curbing global warming, the task in Glasgow is to ensure that action is being delivered.

The pandemic meant vital in-person diplomacy to lay the groundwork for the summit was largely replaced by virtual meetings. Meanwhile, unequal access to covid-19 vaccines and the inequity around delegates' capacity to be in Glasgow has heightened old tensions between high- and low-income countries that have dogged past international climate summits.

But it would be wrong to think that everything was rosy in 2015 and terrible now. "My memory, but human memory in general, is pathetically short," says Christiana Figueres, former executive secretary of UN Climate Change. "We look back at Paris in 2015 and assume everything was already ironed out." That wasn't the case.

There is no single official goal for Glasgow's outcome, but COP26 president Alok Sharma and the UK government, as the host, have framed the meeting's purpose as "keeping 1.5°C alive", a reference to the toughest of the Paris Agreement's targets for limiting warming to less than 1.5°C above pre-industrial levels.

The main way of measuring that is the "emissions gap". This is the chasm between what nations have pledged in their climate plans – known as nationally determined contributions (NDCs) – and what is needed to have a chance of staying under 1.5°C of warming.

New plans in the past year from the US and others narrowed the gap by 3.9 billion tonnes of carbon dioxide a year. But global annual emissions still need to be 20 to 23 billion tonnes of CO_2 lower by 2030, a decrease equivalent to roughly half of global annual emissions now. Even new plans by China and India, which are hoped for in the coming days, have no hope of closing that.

Delegates will need to include something extra to show that the goal could still be met later. One idea is to make the warming goal unambiguously about 1.5°C, rather than the Paris Agreement's fudge of "well below" 2°C and to "pursue efforts" for 1.5°C. Another is to commit to coming back every year with new and better NDCs instead of once every five years, as was agreed in Paris. A faster "ratchet mechanism" like that could let the 1.5°C target be met, but only if stronger plans were then delivered each year. Even the idea of that faster timetable will "be bitterly resisted" by some nations, says a veteran of international climate talks who didn't want to be named.

Another major issue for the summit to resolve is getting enough rich nations to fulfil their promises of climate finance to poorer ones for mitigating and adapting to a warmer world. A target of delivering $100 billion of mitigation a year by 2020 was missed by around $20 billion, and now the race is on to meet that goal before COP26 starts. Failure to do so will seriously damage trust between high- and low-income countries, a precious commodity at a meeting based on consensus, says Saleemul Huq at the International Centre for Climate Change and Development in Bangladesh.

> "Whereas the 2015 Paris meeting's job was to forge a treaty, COP26's task is to ensure action is happening"

COP26 attendees don't have to thrash out a new treaty, but the meeting does have a formal element through which details on how countries tackle climate change in the coming years will be negotiated. This will happen out of public sight as delegates try to agree on an unfinished "Paris rulebook", which includes vital rules on carbon-trading markets, transparency about nations' emissions cuts and common time frames for future NDCs.

Away from those negotiations will be the colourful side of COP26, where celebrities, business leaders and members of civil society from around the world congregate at the conference centre to press their issues, network and protest.

The first two main days of the summit will be dominated by the 100-plus heads of state who will give speeches in person, and others who join virtually. Expect those speeches to trumpet past progress and, in a few cases, announce new targets or policies.

The day after the speeches will focus on finance, which could see a recycling of old news, such as China's pledge to stop funding coal power beyond its borders, but the hope is for new announcements on financiers cutting support for fossil fuels. Other days focus on key thematic issues, such as nature on 6 November and adaptation – measures to cope with the effects of climate change like rising seas and more extreme weather – on 8 November.

Officially, the meeting draws to a close on 12 November. An overarching conclusion is expected to be agreed, but what that contains will be the test of whether COP26 "kept 1.5°C alive". ▮

Attendees

Who's who at the climate talks

A variety of key players will be influencing, or attempting to influence, the COP26 summit in Glasgow

SANDY YOUNG/ALAMY

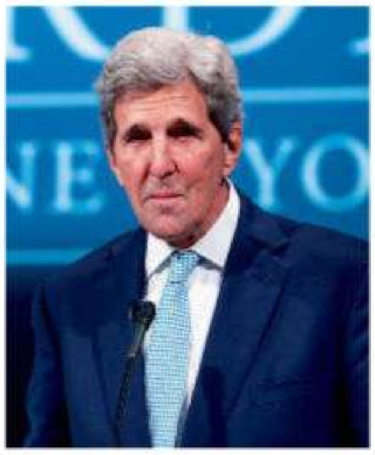
Alok Sharma: COP26 president
The man who must shepherd an ambitious consensus from the 197 parties at COP26. Dubbed "no drama Sharma", he is more technocrat than radical environmentalist. "I'm a normal person, right, I'm not someone who's some great climate warrior," he has said. He is respected and has built relations with governments globally.

SOPA IMAGES LIMITED/ALAMY

Patricia Espinosa: Executive secretary, UN Climate Change
Before taking the reins five years ago at the UN agency charged with coordinating global action on climate change, she was the foreign minister of Mexico. Her job is to work with Sharma to forge a strong outcome at COP26. Her style is circumspect but upbeat. "One thing we cannot do is give up," she has said.

CLAUDIO BRESCIANI/TT NEWS AGENCY/ALAMY

Greta Thunberg: Climate activist
The Swedish campaigner hasn't officially confirmed whether she will attend the summit, but whether she is there in person or tweeting her views remotely, her presence will be felt. She expects Glasgow to just be "blah blah blah" from leaders – words but no action – and for "things to continue to remain the same".



LEV RADIN/SIPA US/ALAMY

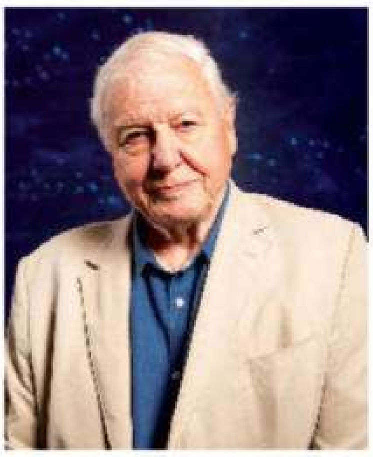
John Kerry: US special presidential envoy for climate
A veteran of the summits that came before COP26 and US president Joe Biden's right-hand man on climate, Kerry has forged a strong partnership with Sharma. He will be a prominent public voice at the conference and an important player in private, urging other countries to reach a bold agreement.

XINHUA/ALAMY

Xie Zhenhua: China's chief climate negotiator
The famously tough climate negotiator for the world's biggest carbon emitter stepped down in 2019, only to be brought out of retirement by Chinese president Xi Jinping this year. Xie and Kerry have a good relationship, which may help as US-China relations are strained on trade, human rights and the origins of the coronavirus pandemic.

PA IMAGES/ALAMY

The Queen, Prince Charles and Prince William
UK royalty will join discussions with other world leaders at the summit. The Queen was recently heard expressing frustration about a lack of action on climate change when she was accidentally recorded as saying "it's really irritating when they talk, but they don't do", while discussing whether world leaders will attend COP26.



PA IMAGES/ALAMY

David Attenborough: Naturalist
As COP26's "people's advocate", Attenborough will address world leaders at the summit. The beloved broadcaster doesn't just have a gift for rhetoric and delivery, but is also closely across the detail on climate change. He has said COP26 is "our last opportunity to make the necessary step change" to protect the planet.

GUGLIELMO MANGIAPANE/REUTERS/ALAMY

Simon Stiell: Climate minister of Grenada
Climate change is "here with us now in Grenada", according to Stiell, who represents not just Grenada, but works with a wider alliance of countries seeking a strong outcome at COP26, known as the High Ambition Coalition. He has also spoken for the Alliance of Small Island States, a group of countries threatened by rising sea levels. ▮

Analysis **Carbon emissions**

Who is tackling climate change best?

Some countries are leading, while others are lagging, when it comes to plans to cut carbon emissions

THE chief aim of the COP26 climate summit is to "keep 1.5°C alive", according to the president of the talks, Alok Sharma. But meeting that Paris Agreement goal of holding global temperature rises to 1.5°C above pre-industrial levels will require bold ambition from countries in their carbon-emission cutting plans for the end of the decade.

Governments had to submit plans in 2015 and were given a deadline of showing "progression" by the end of 2020. Many missed that schedule and the COP26 meeting starting in Glasgow, UK, on 31 October is now a de facto deadline for stronger plans.

So which countries are leading with their new plans for 2030, and which are lagging? Which are contributing a "fair share" – according to calculations by non-profit organisation Climate Action Tracker – to ensuring the world warms by no more than 1.5°C and which aren't? These charts, based on data from the organisation, tell the story (see note at end).

China

Rapid industrialisation and a huge expansion of coal power – the most polluting form of fossil fuel – mean China now accounts for more than a quarter of global emissions. The country is yet to update the original climate plan it submitted in 2015, which allowed for emissions to keep growing and only peak "around" 2030. It has the biggest renewable electricity capacity globally, yet its size, growth and continued reliance on coal for more than 60 per cent of its energy pose a serious challenge to efforts to reduce emissions.

A new plan from China is expected to reflect President Xi Jinping's September promise to reach peak emissions before 2030, but don't expect that to be enough to put the country on a pathway towards its "fair share". There is still hope for China to do better, though. The International Energy Agency has modelled one scenario in which emissions peak in 2025 and decline 4 per cent per year from then, but only by retiring old coal plants and implementing an accelerated roll-out of renewable power and electric vehicles.

US

The US was a key player in forging the Paris Agreement. Yet under former president Donald Trump, it withdrew from the accord, leaving it with no formal plan to cut emissions. Within months of taking office, Joe Biden had rejoined the treaty and set a goal of a 50 to 52 per cent emissions cut by 2030, on 2005 levels. That was at the upper end of expectations.

The US has largely cut emissions in recent years by switching from coal to gas power and, to a lesser degree, renewables. Solar power will be a big plank of the new plan: a recent US government report showed it could go from about 4 per cent of electricity supplies now to 40 per cent by 2035. The country also wants to roll out more electric cars and increase the energy efficiency of homes. The big question over Biden's new climate goal is whether he can navigate domestic politics to secure the spending to deliver it.

Brazil

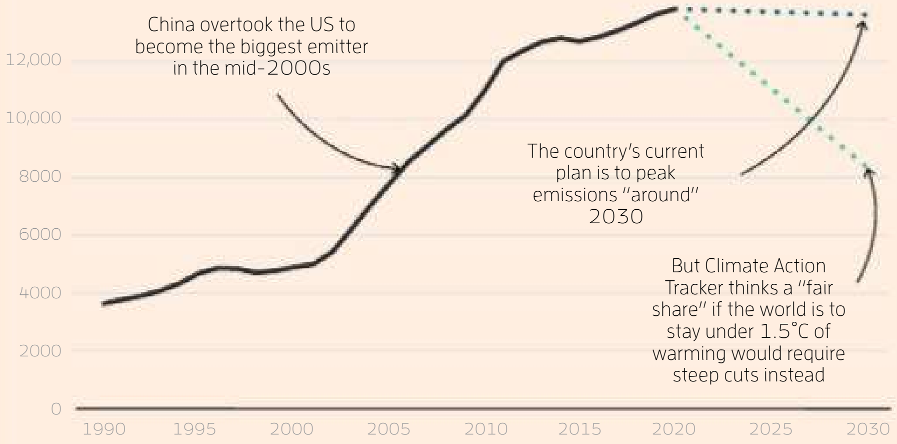
As home to the world's biggest rainforest, a vital store of carbon, Brazil is a crucial player in international climate talks. President Jair Bolsonaro has pledged to make the country carbon neutral by 2050,

Air pollution seen over Lyon, France

PHILIPPE DESMAZES/AFP VIA GETTY IMAGES

China is the world's biggest CO_2 emitter, and still growing

Greenhouse gas emissions in thousands of tonnes of CO_2 equivalent



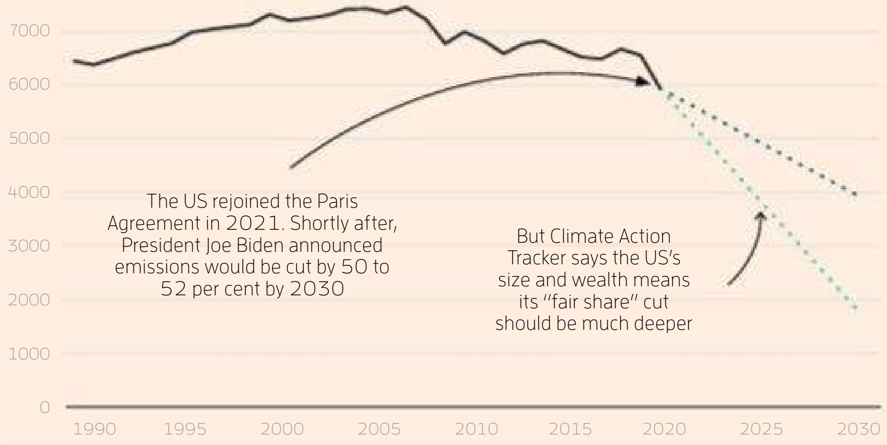
China overtook the US to become the biggest emitter in the mid-2000s

The country's current plan is to peak emissions "around" 2030

But Climate Action Tracker thinks a "fair share" if the world is to stay under 1.5°C of warming would require steep cuts instead

The US plans to roughly halve emissions by 2030

Greenhouse gas emissions in thousands of tonnes of CO_2 equivalent



The US rejoined the Paris Agreement in 2021. Shortly after, President Joe Biden announced emissions would be cut by 50 to 52 per cent by 2030

But Climate Action Tracker says the US's size and wealth means its "fair share" cut should be much deeper contingent on climate finance from richer countries.

But there is a big mismatch between that long-term aspiration and Brazil's short-term plan this decade. Last December, the nation issued a new climate plan for 2030, but left its target from five years earlier entirely unchanged. That flies in the face of the Paris Agreement, where countries promised that each of their successive pledges would be a "progression" on past ones. Worse, a methodology tweak saw a rise in emissions for 2005, the base year from which cuts are measured. That means emissions can go up and the target still be met.

EU

The European Union, the world's third-largest emitter, is usually a progressive force at UN climate talks. However, reaching internal agreement on ambitious climate plans can sometimes be difficult, as some countries, including Germany and Poland, are still heavily reliant on coal.

The bloc updated its plan in December 2020, pledging a 55 per cent cut in emissions by 2030 on 1990 levels – a significant upgrade on its old plan of a 40 per cent reduction. A carbon border tax, steps to encourage renewables and energy efficiency, and efforts to make airlines use greener fuels are some of the ways the EU plans to hit the new goal. Yet Climate Action Tracker says the EU should be going much further to help the world stay under 1.5°C of warming.

UK

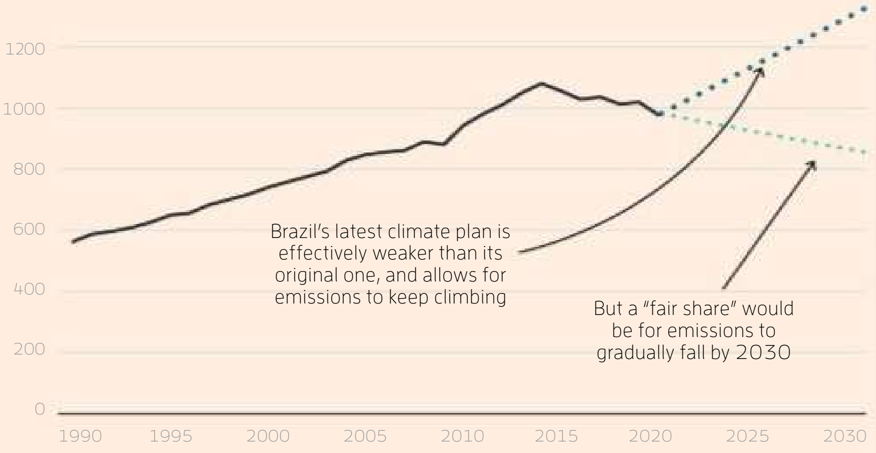
As host of the COP26 summit, the spotlight has been on the UK to show leadership. The country's answer was a pledge last December to cut emissions by 68 per cent on 1990 levels by 2030, the toughest target of any major economy. While world-leading, there is still a question mark over whether the UK government will put the policies in place to meet the goal. The UK is already off track for earlier targets it set domestically.

Last week, the UK government published its "net-zero strategy", but this was criticised for not showing the carbon savings that any of its measures would deliver.

It is also worth noting that the UK is one of a few countries, like Germany, whose fair share towards a 1.5°C goal would require the country to pull more carbon dioxide out of the atmosphere than it puts in, known as negative emissions. That is mainly because of the UK's large historical emissions, but partly due to its capability to cut emissions. ▮

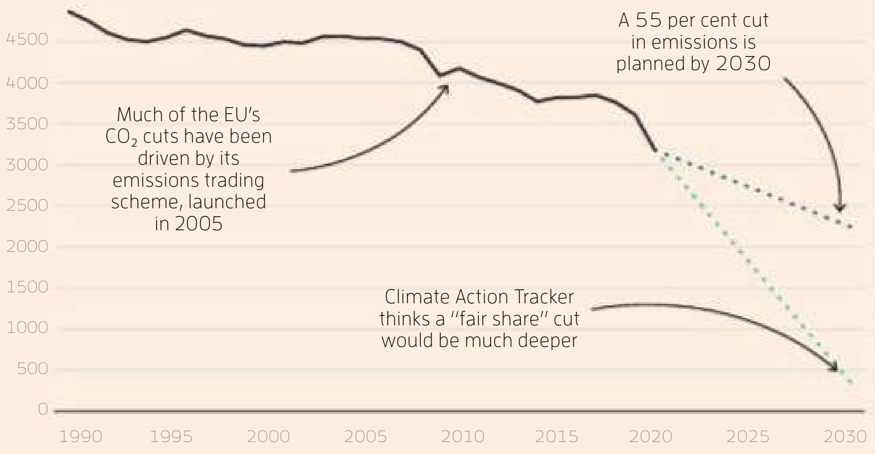
Brazil's climate plans have gone backwards, not forwards

Greenhouse gas emissions in thousands of tonnes of CO_2 equivalent



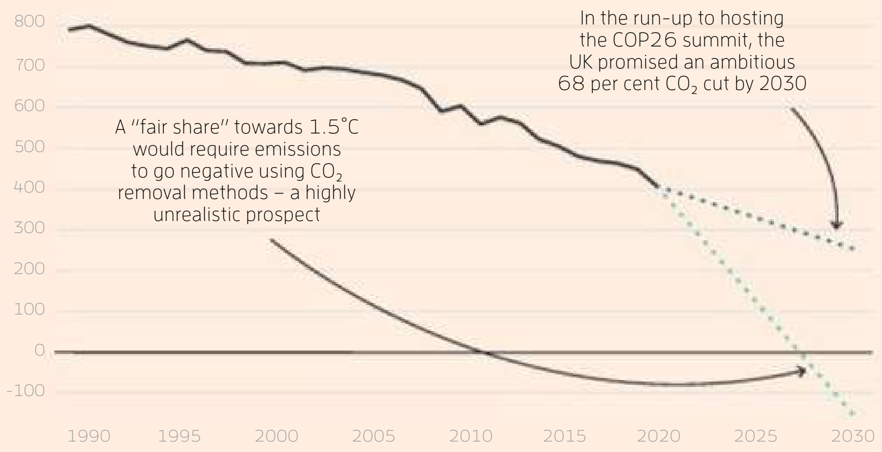
EU emissions are already falling but need to speed up

Greenhouse gas emissions in thousands of tonnes of CO_2 equivalent



The UK's 2030 climate plan is one of the most ambitious

Greenhouse gas emissions in thousands of tonnes of CO_2 equivalent



A brief note on the data

The dotted blue lines indicate the path implied by the average emissions in 2030 under the carbon-cutting plans, officially called nationally determined contributions (NDCs), that countries have submitted to UN Climate Change. Many countries provide a range. The emissions cuts here are only those that are unconditional in NDCs. Some countries promise deeper cuts providing richer countries hand over promised climate finance.

The dotted green lines show the "fair share" for each country if the world is to achieve the 1.5°C goal, as calculated by Climate Action Tracker. The solid black lines show historical emissions. All the figures exclude emissions from land use, land-use change and forestry. For most Western nations, such as the UK, these are marginal.

Interview: Ed Miliband

The anarchy of negotiation

There are important lessons to be learned from previous UN climate meetings. Ed Miliband discusses his time at the failed COP15 summit

AROUND 25,000 delegates will descend on Glasgow, UK, for COP26, a climate conference like no other. As a key player at one of the most important climate summits that preceded it, Ed Miliband has a better insight than most on what those people will experience.

Miliband, who is currently shadow business secretary for the UK's Labour Party, was the nation's climate minister at the COP15 climate summit in Copenhagen in 2009, which was widely seen as a flop for failing to make a breakthrough on global action to curb emissions.

With 197 countries and blocs party to the UN Framework Convention on Climate Change, which oversees the climate talks, Miliband likens the process to 190-dimensional chess.

"This matters hugely to so many countries and you're trying to do a really difficult thing"

"I think people underestimate – and I fear the UK government has underestimated – the complexity of the process," he says. "It's not like any other international summit, it's not coming out with a pre-prepared communiqué. Of course, there's been negotiations, but it's a relatively chaotic process. It's a process that requires unanimity."

He recalls the then UK prime minister Gordon Brown negotiating with other leaders through the night in 2009 to end a deadlock and agree a three-page document, the Copenhagen Accord. "Gordon's parting words for me before he left for London the next morning were, 'I'm glad we've got this, but don't screw it up', except he didn't use the words 'screw it up'."

But late that day, things went awry. "That night, as I was going to bed, Pete [Betts, then the UK's chief climate negotiator] rang me while I was standing in my pants in my hotel room and said 'it's all going down the toilet. The agreement is an empty shell'." Miliband, who was worried about both the geopolitical ramifications and Brown's reaction, rushed back to the conference centre.

There, he found a Sudanese diplomat giving a speech comparing the accord to the Holocaust. With the UK's microphone not working, Miliband took the US one to say: "We can't have come this far and just junk the agreement."

One infamous moment near the end of the Copenhagen summit was captured in a photo of a stony-faced Barack Obama and other world leaders crammed into a small, windowless room. "I was on the edge of that picture, the story of my life," laughs Miliband, who was leader of Labour when it was defeated at the UK's 2015 general election. "It felt quite anarchic. There was very little control over who was and who wasn't in the room. I remember Obama being there and could see him thinking 'what am I doing there'."

RICHARD TOWNSHEND PHOTOGRAPHY

Profile

Ed Miliband was the UK's climate minister at the Copenhagen climate summit in 2009 and is a sitting member of the UK parliament

STEFFEN KUGLER–POOL/GETTY IMAGES

There were tense negotiations between world leaders at COP15 in Copenhagen in 2009

On his overall memory of Copenhagen, Miliband says: "It's such a blur. My memory is no sleep. Endless meetings." He recalls nearly running into the then Russian president, Dmitry Medvedev, at one point and asking him if he would increase his climate targets.

"It sounds a bit anarchic, but there's a reason why it's so difficult. This matters hugely to so many countries and you're trying to do a really difficult thing [mitigate climate change]," says Miliband.

COP26 faces its own set of challenges, mainly how to put the world more closely on track for the 2015 Paris Agreement's promise to "pursue efforts" to hold global warming to 1.5°C and "well below" 2°C. Current plans would see global emissions rise by 16 per cent by 2030, rather than fall by 45 per cent as is needed for a chance to stay under 1.5°C.

Miliband says: "I think we're a long way off where we need to be. And I think the truth is we've got to push as hard as we possibly can to get the 2030 numbers up. But we've got to tell the truth. This is a question of maths."

Being honest about the reality of emissions is crucial – not to "cast a downer on everybody", he says, but to remind countries that they should commit to returning as soon as next year with new emissions plans, rather than waiting until 2025 as is currently agreed.

Nonetheless, he doesn't think Glasgow will be a repeat of Copenhagen's failings. "I don't think it's comparable to Copenhagen. We're not going to have another Copenhagen. The political will, the business will is too strong. It's not going to fall apart." ▮

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Fertility

Male fertility could be restored with frozen testicular tissue implants

Michael Le Page

A CLINIC in Belgium has been given the go-ahead to reimplant frozen testicular tissue to obtain sperm for fertility treatments. The hope is that this will allow those whose fertility was destroyed by cancer treatments before they reached puberty to have children.

"Our protocol has been approved by the ethical committee, and now we are waiting for the first case," says Ellen Goossens at the Free University in Brussels (VUB).

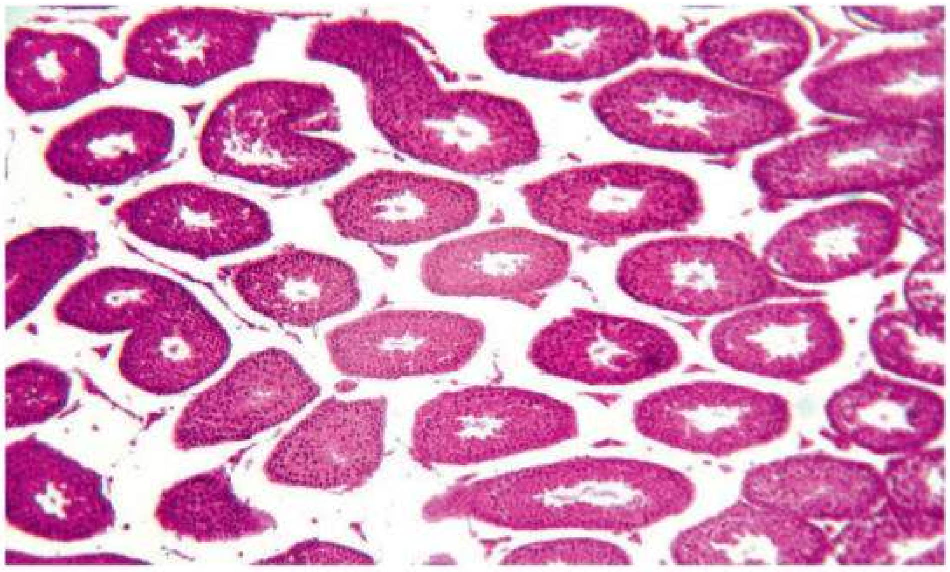
Cancer treatments such as chemotherapy or radiotherapy can sometimes make people infertile. In those old enough to produce sperm, samples can simply be frozen for later use for IVF. For prepubescent children who don't produce sperm yet, this isn't an option, but their testes do contain spermatogonial stem cells, which later produce sperm. These can be preserved by removing small pieces of the testes and freezing them.

After animal studies suggested that it might be possible to derive mature sperm from such cells, Goossens's group began offering testicular tissue banking in 2002. A growing number of centres worldwide are following suit, and a survey in 2019 found that testes tissue had been collected from more than 1000 individuals.

A breakthrough in the animal studies came recently, says Rod Mitchell at the University of Edinburgh in the UK, who wasn't involved in the work. A US team froze testicular tissue from rhesus macaques and reimplanted it in the scrotum or under the skin of the back. All the grafts produced testosterone and mature sperm, which were extracted and used to fertilise eggs. In 2019, the team reported that the process led to the birth of a healthy macaque.

"This is proof of principle in the primate that the whole process from obtaining tissue, storing tissue, generating sperm and being able to generate offspring with those sperm is feasible," says Mitchell. Now, several centres have begun preparing to try reimplanting testicular tissue into the individuals from whom it was taken. Goossens's group is likely to be the first.

A cross-section of human testicular tissue



DAVID HERRAEZ/ALAMY

"Since we were the first worldwide to offer testicular tissue banking to prepubescent boys, we now have the oldest cohort, including patients in their mid-twenties," she says. Some of them may now want to start families and find that natural conception isn't possible, says Goossens.

These first attempts will be done as part of a clinical trial, says Mitchell. It may be several years before the procedure is tried in other countries.

Researchers are also exploring other ways of generating sperm from the frozen tissue. One is to try to grow the stem cells in the lab and generate sperm without reimplanting tissue into the body. On 19 October, researchers in the US reported that they had fertilised rhesus macaque eggs with sperm generated from stem cells. Another possibility is reimplanting the stem cells into the tubes of the testes in a way that spurs normal sperm production. ▮

Machine learning

AI can turn collection of 2D images into an explorable 3D world

AN ARTIFICIAL intelligence algorithm can transform still images into a high-resolution, explorable 3D world, with potential implications for film effects and virtual reality.

By feeding the neural network a selection of images of a scene and a rough 3D model of the scene created automatically using off-the-shelf software called COLMAP, it is able to accurately visualise what the scene would look like from any viewpoint.

The neural network, developed by Darius Rückert and colleagues at the University of Erlangen-Nuremberg in Germany, is different to previous systems because it is able to extract physical properties from still images.

"We can change the camera pose and therefore get a new view of the object," says Rückert.

The system could technically create an explorable 3D world from just two images, but it wouldn't be very accurate. "The more images you have, the better the quality," says Rückert. "The model cannot create stuff it hasn't seen."

Some of the smoothest examples of the generated environments use between 300 and 350 images captured from different angles (arxiv.org/abs/2110.06635).

Rückert hopes to improve the system by having it simulate how light bounces off objects in the scene to reach the camera, which would mean fewer still images are needed for accurate 3D rendering.

"The rendering quality is unparalleled. It is proof that photorealism is possible"

"The rendering quality is unparalleled," says Tim Field, founder of New York-based company Abound Labs, who works on 3D capture software. "It's proof that automated photorealism is possible."

Field believes the technology will be used for generating visual effects in films and virtual reality walkthroughs of locations.

"It's going to accelerate the already-hot research field of machine learning-based rendering for computer-generated imagery," he says. ▮

Chris Stokel-Walker

Solar and wind power are important parts of our renewable energy plans but in the long term, clean hydrogen must be the focus, says Statkraft's **David Flood**

Green hydrogen is key to building a net zero economy

The world needs to decarbonise rapidly if we are to meet our climate targets – and the extreme floods, heatwaves and wildfires of the last few years have highlighted why it is so urgent that we do so.

As the science behind the causes and impacts of climate change becomes increasingly certain and stark, governments are increasing their ambitions from limiting temperature rises to 2°C to working towards a 1.5°C target. It is vital to do this to limit the worst impacts of climate change, but to achieve it requires a substantial increase both in political ambitions and in the pace of global action to cut emissions.

Already, the pace of change in the green economy is so rapid that it can be hard to keep up. But a few things are becoming clear. The energy system will become increasingly electric, and electric power will increasingly be provided by wind and solar because they will provide the lowest cost electricity.

Even in the face of the covid-19 pandemic, investment in renewable power rose in 2020. While total car sales fell, sales of electric vehicles rose by 40 per cent. By 2050, there will be 21 times as much solar power and seven times as much wind capacity to meet electricity demand, which will itself more than double during that period.

We are electrifying everything because it is a more efficient use of energy. A heat pump uses a third of the energy that a gas boiler does, for example, while an electric car needs around a third of the energy of a traditional car to travel the same distance. And if we're using electricity, we can also cut emissions by making that power renewable.

As the proportion of intermittent and variable renewables on the network increases, that network needs to become increasingly flexible. Where it is available, hydropower is a great option because it can be switched off and on at the drop of a hat. But other types of energy storage, interconnectors with other markets and demand-side response will all be important, too.

Green hydrogen, which uses renewable electricity to split hydrogen from water, is a technology whose industrial potential is still being realised. However, it will come to play several crucial roles in the future energy system, including storing energy for long

"By 2050, there will be 21 times as much solar power"

STATKRAFT

STATKRAFT

Our future energy system will become increasingly electric

periods and decarbonising industries such as ammonia, refineries and steelmaking.

In such "hard-to-abate" sectors, it is difficult to use electricity directly to replace fossil fuels to cut emissions, because carbon is central to current production processes. But these industries can use hydrogen instead, providing a way to apply the electrification revolution to areas that would otherwise be unable to benefit from it. And by creating that hydrogen using renewable energy, we can provide a way for these industries to decarbonise – something that was thought impossible just a few years ago.

Hydrogen can also be used in heating and transport – particularly heavy transport such as trucking, trains and shipping.

Green hydrogen also creates a market for renewable energy when supply is higher than demand. It's a mechanism for storing excess renewable energy and helping to smooth out generation costs and power prices; so investing in building up hydrogen reserves will see a more resilient energy system.

There has been so much talk about the hydrogen economy that it is easy to forget that clean hydrogen remains largely on the drawing board today. In 2020, global capacity of the electrolysers needed to produce green hydrogen was just 200 megawatts. By 2040, this is predicted to grow to 200 gigawatts, a 1000-fold increase.

But just as important as increasing the supply of clean hydrogen is the need to create new demand. Globally, we currently produce 87 million tonnes of hydrogen from natural gas, with more than 10 tonnes of CO_2 produced for every tonne of hydrogen. The first priority is to decarbonise this "grey" hydrogen. This can initially be done by adding carbon capture and storage (CCS) technology to the steam methane reforming plants that currently produce what's known as "blue" hydrogen.

Blue hydrogen is very much a bridging technology, though, and question marks remain about the emergence of CCS, whose promise has consistently failed to emerge over the years.

In the longer term, green hydrogen will become the preferred solution. As production scales up and the cost of electrolysers and the associated infrastructure falls, along with the further expansion of renewable energy capacity, it will become the dominant source of the gas. The cost of electrolysers has already fallen 60 per cent in the past five years, and we predict that the total cost of producing green hydrogen will fall by the same amount by 2050.

By 2050, Statkraft's Low Emissions Scenario suggests that current grey hydrogen production will be almost fully replaced by blue and green hydrogen as the industrial hydrogen race heats up. As of September this year, 20 countries as well as the EU have launched hydrogen strategies, with a further 23 in the process of doing so, including the US, Brazil and China.

Over the past two years, Europe has taken a leading role globally in establishing clean hydrogen industry, in terms of ambition, financial support and number of projects.

In addition to hydrogen consumption for feedstock in industry, clean hydrogen will also account for 5 per cent of global final energy demand by 2050 and could account for up to a fifth of Europe's power demand. The increase in total hydrogen demand up to 2050 will primarily be from new uses of hydrogen, such as in the steel industry and long-distance transport (including clean ammonia for maritime transport).

We have started on the path to a net zero economy, powered by renewable energy. Quick-to-deploy wind and solar power must be developed at pace to take their place as our lead energy sources in the coming years. However, even with unprecedented renewables development, we will not meet required targets without green hydrogen.

David Flood, Country Manager
Statkraft UK

Astronomy

Titan may be doomed to fly away or smash into Saturn

Leah Crane

SATURN'S largest moon Titan has an outsized effect on the planet's tilt, and its outwards migration could knock the planet onto its side and doom Titan itself.

Titan is moving away from Saturn at a rate of about 11 centimetres per year. That isn't too strange – Earth's moon is migrating away from our planet too, at a rate of just under 4 centimetres per year – but it is unexpectedly fast. As Titan's orbit moves further from Saturn, it affects the planet's spin by making it wobble more quickly on its axis.

"If Titan goes on migrating as predicted from this observed rate, then the axis tilt of Saturn will probably grow in the next billions of years," says Melaine Saillenfest at the French National Centre for Scientific Research. He and Giacomo Lari at the University of Pisa in Italy simulated this process. They found that Saturn will eventually reach a tilt of 90 degrees, meaning its spin will be perpendicular to the plane in which it orbits the sun (arxiv.org/abs/2110.05550).

A similar mechanism could explain why Uranus is tilted by 98 degrees, a feature that has largely been attributed to collisions in the planet's past. That is still under debate, though, so this alternate mechanism could be a solution.

If Titan's orbit continues to widen, it will eventually reach a point at which various gravitational forces destabilise its trajectory. The team found that this will happen when Titan is about twice as far from Saturn as it is now. At that point, Titan will probably be either tossed out of Saturn's system or fall towards the planet.

This will take billions to tens of billions of years, so it may not actually happen. If it takes long enough, the sun will become a red giant before then, devouring the inner planets and catastrophically reshaping the entire solar system. ▮

Technology

El Salvador's adoption of bitcoin hits further problems

Luke Taylor

There have been protests against bitcoin in El Salvador

REUTERS/JOSE CABEZAS VIA ALAMY

FOLLOWING its move to become the first country in the world to make bitcoin legal tender on 9 June, El Salvador's government has had to deal with protests, fraud, market volatility and technical glitches.

Now the Central American nation has had to suspend a key function in Chivo Wallet, the government-issued smartphone app used to store and exchange bitcoin, because economic traders were exploiting it to make a profit.

El Salvador's president, Nayib Bukele, has touted bitcoin as a way to save Salvadorans an estimated $400 million a year lost in remittance fees, to bring banking to the 70 per cent of the population that lacks access and to boost the nation's economy.

However, because bitcoin is a nascent currency, its value swings wildly, and it plunged 17 per cent on 7 September when Chivo Wallet launched.

To encourage bitcoin exchanges, Chivo Wallet allowed users to freeze prices for 1 minute when previewing them. It was intended to stabilise transactions and ensure that, for example, a customer knew how much they were paying for a restaurant meal and the restaurant knew how much it was receiving.

But traders have been exploiting the function by comparing the wallet's frozen price against bitcoin's real time market value when exchanging it for US dollars. If the market price of bitcoin rises during the 60 seconds after the freeze, they buy the cryptocurrency at the wallet's lower frozen price. If the price falls, they sell it.

70%

of El Salvador's population lacks access to traditional banking

This practice, which is legal, is known as scalping. Chivo Wallet announced that it was suspending the value-freezing function and all visibility of pricing on 18 October because it claimed people were using it to commit "fraud" to make "endless" profit.

While other cryptocurrency exchanges cover losses from scalping with their commission fees, in El Salvador it is taxpayers who foot the bill with a $150 million state trust fund backing the currency.

The issue further erodes confidence in Bukele's vision of the country becoming a crypto-state, and critics say it shows the naivety of trying to regulate an anarchic currency designed to be decentralised.

"Everyone is blinded now, they have no idea what price they're buying bitcoin at," says Oscar Salguero, a crypto enthusiast from El Salvador who says Chivo Wallet was rushed out before it was ready for commercial use.

The Salvadoran presidency and Chivo Wallet didn't respond to a *New Scientist* request for information on how they will address the new problem.

"Chivo" is slang for cool, but the reaction from Salvadorans, most of whom distrust bitcoin and oppose businesses being forced to accept it, has been anything but. Many have taken to Twitter to complain and some have protested on the streets.

In July, many Salvadorans found that the $30 in bitcoin they were promised for opening a Chivo Wallet had already been claimed with identity fraud.

As well as bitcoin's volatility making it unsuitable for use as a national currency, a lack of internet coverage and trust in government in El Salvador means that it is doomed to fail, says David Gerard, author of *Attack of the 50 Foot Blockchain*. ▮

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Next year, UK spaceports will become capable of hosting space launches from the UK for the first time. The development is part of an ambitious plan to make the UK a meaningful actor in space, both in military and civilian spheres, and to allow British industry to exploit new space-related technologies for smaller, cheaper and more effective satellites. To make this happen, the government recently set out its National Space Strategy and created the UK Space Command to defend British interests and guarantee secure communications in space; it also introduced the legal framework necessary to allow launches from British soil. But is Britain ready for the challenge?

This *New Scientist* debate will ask whether Britain has the expertise and industrial base to meet these ambitions and explore how it can best exploit these foundations in an increasingly competitive global market for space.

Panellists

George Freeman, MP
Minister for Science Research and Innovation

Air Vice-Marshal Paul Godfrey
Commander of the UK Space Command

Emily Gravestock
Head of Applications Strategy, UK Space Agency

Dave Short
Technology Director, BAE Systems

Justin Mullins
Consultant editor, *New Scientist* and debate chair

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Animals

On the origins of horses

A DNA study has revealed the time and place that horses were first domesticated

Michael Marshall

ONE of the most stubborn mysteries in prehistory has finally been reined in. A massive study of ancient DNA has revealed where horses were saddled up: on the steppes of central Eurasia, near the Volga and Don rivers in what is now Russia, around 2200 BC.

"Finally, we find where and when horses were domesticated," says Ludovic Orlando at Paul Sabatier University in France.

The domestication of horses was a crucial event because it revolutionised travel and warfare. Horses can carry riders and pull wheeled vehicles, enabling people to journey far faster than before.

However, despite decades of effort, it hasn't been possible to pin down where this event happened. That is partly because domestic horses are about the same size as their wild ancestors and don't look significantly different – unlike most domestic animals. That means looking at ancient horse bones cannot tell us when the shift happened. "You don't have an obvious smoking gun," says Orlando.

As recently as two years ago, there were as many as five locations that were serious candidates for the site of domestication, says Alicia Ventresca Miller at the University of Michigan in Ann Arbor. They range from what is now Spain to present-day Mongolia.

To try to resolve the mystery, Orlando teamed up with dozens of researchers to compile 273 genomes of ancient horses from all over Eurasia, plus 10 genomes from modern domestic horses. Most of the ancient horses had been carbon-dated, so their ages were known.

The DNA from the modern domestic horses was most similar to that of ancient horses once living on the steppes of western Eurasia, in the region where the Volga and Don rivers flow from north to south and drain into the inland Caspian Sea (*Nature*, doi.org/g3hc).

This ancestral group of horses had separated from other horse populations by around 3000 BC. Then, after about 2200 BC, what had been a small population of modern-like horses in the Volga-Don region increased vastly both in number and in range. Within a few centuries, horses with similar genetic make-up were found as far afield as Europe, Anatolia and what is now Kazakhstan.

The implication is that horses were domesticated in the Volga-Don region in the centuries before about 2200 BC, says Orlando. These horses proved so useful that they then rapidly spread all over Eurasia.

In September, Ventresca Miller and her colleagues published a study of the proteins preserved on ancient people's teeth, revealing that people in roughly the same region of central Eurasia began drinking a lot of horse milk between 3000 and 2000 BC. "The genomic data that they present really aligns well with the proteomics data that we've been analysing," says Ventresca Miller. "Now, we have sort of irrefutable evidence that horses were domesticated in this locale."

Horses running in the steppes of Inner Mongolia, China

LUDOVIC ORLANDO/CAGT/CNRS PHOTOTHÈQUE

Technology

AI can change a fashion model's pose and clothing

SOON, the model showcasing your online clothing purchases may not have actually made the pose in the picture. A neural network can now repose people and change their clothes in photographs without losing key details.

Badour AlBahar at Virginia Tech in Blacksburg and her colleagues developed an algorithm that breaks down an image into constituent body parts, with a neural network identifying key joints and limbs. It is then fed the target pose of how the user wants the model to stand, before it identifies the new positions of relevant body parts.

At the same time, the AI uses generative adversarial networks – the technology behind deepfake videos and images – to reposition important elements. This requires flattening out the face or clothes into a 2D image and then wrapping it back round the reposed body using an ultraviolet colour-coded heat map to show where the relevant parts need to go. The same technique allows the neural network to swap out clothes by cutting and pasting different items onto a body (arxiv.org/abs/2109.06166).

The AI is largely successful, but struggles to accurately move hands because of a lack of detail around fingers in DensePose, a pre-existing technology the process uses. It also becomes less accurate when asked to repose people of colour, mutating their faces in an unnatural way.

"This is a mind-blowing use of image generation. It could be improved by fixing the biases"

"We use fashion data sets, and when you think about models, the data is not very diverse," says AlBahar. "It's very difficult for us to train on that data set and extend it to a more diverse set of people." She hopes to improve the model with more diverse data sets.

"This is a mind-blowing use of style-guided and human-conditioned image generation," says Niki Martinel at the University of Udine, Italy. "It could be improved by fixing the biases. But this could give huge possibilities to fashion design and retailers."

Chris Stokel-Walker

Astronomy

Dimmest supernova ever seen puzzles astronomers

Leah Crane

THE faintest supernova ever spotted has been seen in a galaxy about 88 million light years away. It is so dim that it doesn't seem to fit existing models produced to explain the faintest supernovae.

Viraj Karambelkar at the California Institute of Technology and his colleagues found the cosmic explosion, called SN 2021fcg, using the Zwicky Transient Facility in California. At its peak, it put out about three times less light than the previous record holder for the faintest supernova (arxiv.org/abs/2110.04306).

"It's at least 100 times fainter than a normal supernova of this type," says Karambelkar. "But even though this is dim for a supernova, it's still 10 million times brighter than the sun."

Generally, this kind of supernova, called a type Ia, occurs in binary star systems where a white dwarf gradually pulls matter from its companion star until it becomes too massive to support itself, at which point it explodes. However, SN 2021fcg is too dim to have formed via that mechanism.

There are two models that could explain its dimness. The first, which has been proposed for other unusually faint supernovae, is that a particular type of white dwarf could partially ignite, blowing off some of its plasma without completely exploding. However, that process is expected to create explosions about three times brighter than this one.

The other model involves a white dwarf with a core of carbon and oxygen smashing into another with a core of oxygen and neon, but is expected to cause explosions about three times dimmer than this one.

"SN 2021fcg remains between these two, so it remains to be seen whether we can get either of those models to match this explosion," says Karambelkar. "It's a problem." ▮

Coronavirus

Covid-19 vaccines reduce the likelihood of infecting others

Michael Le Page

FREDERIC J. BROWN/AFP VIA GETTY IMAGES

A nurse administers the Pfizer/BioNtech vaccine in Los Angeles

PEOPLE who are fully vaccinated against covid-19 are far less likely to infect others, despite the arrival of the delta variant, several studies show. The findings refute the idea that vaccines no longer do much to prevent the spread of the coronavirus.

"Vaccinated people do transmit the virus in some cases, but the data are super crystal-clear that the risk of transmission for a vaccinated individual is much, much lower than for an unvaccinated individual," says Christopher Byron Brooke at the University of Illinois at Urbana-Champaign.

A recent study found that vaccinated people infected with the delta variant are 63 per cent less likely to infect people who are unvaccinated (medRxiv, doi.org/g3p3). This is only slightly lower than with the alpha variant, says Brechje de Gier at the National Institute for Public Health and the Environment in the Netherlands, who led the study. Her team had previously found that vaccinated people infected with alpha were 73 per cent less likely to infect unvaccinated people.

What is important to realise, de Gier says, is that the full effect of vaccines on reducing transmission is even higher than 63 per cent, because most vaccinated people don't become infected in the first place.

Others have looked into this full effect. Earlier this year, Ottavia Prunas at Yale University applied two different models to data from Israel, where the Pfizer/BioNtech vaccine was used. Her team's conclusion was that the overall vaccine effectiveness against transmission was 89 per cent.

> "Vaccinated people who have delta are 63 per cent less likely to infect unvaccinated people"

However, the data used only went up to 24 March, before delta became dominant. The team is now using more recent data to work out the impact of delta, says Prunas.

The idea that vaccines are no longer that effective against transmission has circulated in some groups and may derive from news reports in July claiming that vaccinated people who become infected "can carry as much virus as others". But even if this were true, vaccines would still greatly cut transmission by reducing infections in the first place.

In fact, the study that sparked the news reports didn't measure the number of viruses in someone directly but relied on so-called Ct scores, a measure of viral RNA. However, this RNA can derive from viruses that have been destroyed by the immune system. "You can measure the RNA, but it's rendered useless," says Timothy Peto at the University of Oxford.

Yet another line of evidence comes from a study by Brooke. His team took samples from 23 people every day after they first tested positive until the infection cleared and performed tests, including trying to infect cells in a dish with the samples.

With five out of the six fully vaccinated people in the study, none of the samples were infectious, unlike most from unvaccinated people. The study shows that vaccinated people shed fewer viruses and also stop shedding sooner than those who are unvaccinated, says Brooke.

The one bit of bad news is that Peto's study shows that the protection a vaccine provides against an infected person infecting others does wane over time, by around a quarter over the three months after a second vaccine dose. "This has made me a believer in boosters," says Peto. ▮

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Field notes The path to net zero

A wooden circular economy Finland wants to make everything from ceramics to medical devices and even satellites from wood, helping it to hit carbon neutrality by 2035, finds **Graham Lawton**

GRAHAM LAWTON

Giant machines can make quick work of managing forestry areas

I AM in a forest in Finland watching trees die a brutal death. A monstrous machine like something from *The War of the Worlds* is lumbering among the pines, its deadly arm swaying menacingly. Every now and again it selects a victim, grasps it at the base and slices through the trunk like butter. As the tree crashes through the canopy, the machine – called a Scorpion – raises it aloft as if in triumph, strips the branches and butchers the trunk into three. It is all over in seconds.

Despite the apparent ruthlessness, this is how benign forest management is done in a country that is betting the farm on wood. Finland is aiming to be carbon neutral by 2035, largely by creating a "circular bioeconomy" – one in which all the material and energy inputs come from sustainable wood or renewable energy, and all the products are 100 per cent recyclable. Fossil fuels are history.

That brave new economy starts right here. The forest I am visiting is on a farm about 100 kilometres north of Helsinki. The current owners, Laura and Mika Hämäläinen, are the latest in a long line of family members involved in the business. Their 350-hectare forest has been passed down the generations since 1724.

Family ownership of forests is the norm in Finland: about 60 per cent of its 23 million hectares of woodland is owned by 600,000 private individuals. They can largely do as they please with their trees, but many are enlightened, long-term owners who understand the concept of a circular bioeconomy and manage their forest accordingly, says Marko Mäki-Hakola, forest director at MTK, Finland's federation of farmers and forest owners.

Today's operation is called thinning, where about 10 per cent of the trees are chopped down to give others light and space to reach their full potential. This pinewood was planted in the 1960s and has been thinned twice before. In another 20 years, most of the remaining trees will be felled and the area replanted.

So far, so conventional. But where this differs from regular forestry is the attention that is paid to the needs of biodiversity and the climate. Most of today's harvest will be sent to a sawmill for processing, but some will be left to become dead wood, a vital habitat for up to 5000 species of animals and fungi. Some trees are cut off about 2 metres up and left standing as "high stumps", another form of dead wood with its own ecosystem.

"Nature management is part of forest management," says Markus Nissinen, MTK's local environmental specialist. The way the Hämäläinens manage their forest aims to balance the needs of humans and nature, while keeping the ecosystem healthy for future generations, he says.

100 million

Cubic metres of wood that grows in Finland's forests each year

Taking this nature-based approach is also good for the climate. According to Jari Leppä, Finland's minister of forestry and agriculture, the country's forests grow by just over 100 million cubic metres of wood per year, about 70 per cent of which is harvested. This is plenty for a bioeconomy and also to meet Finland's climate goals. The net effect is its forests sequester 16 million tonnes of carbon dioxide a year, about a third of total emissions, and as the country phases out coal, it is on track to be carbon neutral by 2035.

Forest owners are also flocking to a voluntary MTK scheme that pays them to set aside areas for biodiversity. The Hämäläinens take me to a wood that is managed as a habitat for Siberian flying squirrels, which are vulnerable in this region. There are also lynx, though they are rarely seen.

Later that day, I visit companies and researchers that are putting Finland's wood to work, from construction materials to novel applications such as ceramics, clothing, medical devices, industrial chemicals, fibre-optic cables and even a satellite. Much of this is in the R&D stage, but these are the tiny acorns from which a new world economy can grow.

Of course, Finland is an ideal candidate to create a wood-based bioeconomy: it is 75 per cent forested and has no fossil fuel deposits to fall back on. But the model is being copied by other northern nations such as Russia and Canada, says Leppä.

Temperate countries with very different types of forest, such as the UK and Ireland, also have much to learn, says ministerial adviser Elina Warsta. To get where we need to be by 2050, it seems the world needs to follow Finland's lead and start tearing up some trees. ▮

Graham's visit was paid for by the Finnish embassy in London

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[1] Source: Global Cement and Concrete Association

[2] Annual global cement production in 2019: 4.1 billion tonnes. Source: IEA.

[3] Precast industry is 30% of total. Sources: The Business Research Company & Fortune Business Insights.

[4] Typical passenger vehicle emits around 4.6 metric tonnes of CO_2 per year. Source: EPA.

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[1] IEA (2017), The Future of Trucks, IEA, Paris

[2] IEA (2020) CO_2 emissions from heavy-duty vehicles in the Sustainable Development Scenario, 2000–2030

[3] One young tree absorbs 5.9kg CO_2 per year. Source: Urban Forestry Network.

POTEKO/ALAMY

Disease

Cats linked to toxoplasmosis spike in wildlife near cities

WILD animals living close to cities are more likely to carry the parasite that causes toxoplasmosis, and house cats may play a major role in spreading it to wildlife.

Toxoplasmosis is caused by the pathogen *Toxoplasma gondii* and can infect any warm-blooded animal, including us. Between 30 and 50 per cent of all humans have been infected with *T. gondii*, with most cases asymptomatic. But for people and animals with weakened immune systems, the infection can lead to chronic illness or even death.

Wild and domestic cats are the primary hosts of *T. gondii*, which matures and reproduces inside them. One of the most common ways toxoplasmosis spreads is through contact with cat faeces.

Amy Wilson at the University of British Columbia in Canada and her colleagues analysed 45,079 cases of toxoplasmosis in 238 species of wild mammals, from 202 published studies. The researchers compared rates of infection with factors such as human population density, annual rainfall and temperature to identify the predictors of toxoplasmosis prevalence.

They found a high prevalence of the disease in wild mammals living close to cities and a strong link between warmer temperatures and high infection rates (*Proceedings of the Royal Society B: Biological Sciences*, doi.org/g3dc).

The results support suggestions that freely roaming pet cats are a key driver of these infections, says Wilson. She suggests that responsible management of domestic cats could help limit the spread of the pathogen. **Chen Ly**

Neurology

Mini-brains in a dish kept alive for a year

MINIATURE human brain-like structures have been grown in a dish for more than a year, much longer than possible before. This was accomplished by growing brain cells into a ball, then slicing it up so that oxygen and nutrients can reach all the cells, while allowing the structure to retain its internal tissue architecture.

The standard way to study tissues kept alive in the lab is to grow a single layer of cells in a dish. Then it was found that if the cells could be coaxed into a pea-sized ball known as an organoid, they mature into different cell types that interact with each other more naturally.

But such organoids tend to start dying and breaking apart after a few months because they have no blood supply, so not enough oxygen and nutrients can reach the core. This makes it harder to carry out experiments on them, says András Lakatos at the University of Cambridge.

While some groups are trying to develop organoids with blood vessels, Lakatos and his team tried a new tactic: cutting up brain organoids into slices about 10 cells thick. They reported keeping the mini-brains alive for eight months (*Nature Neuroscience*, doi.org/g3dg) – but Lakatos says some have actually survived for just over a year. "You still see quite good cell diversity and architecture resembling the fetal brain," he says.

Some of the mini-brains were made from cells taken from people with motor neurone disease. These behaved differently to those made from cells taken from people without the condition, which may one day lead to new ways to treat the illness, says Lakatos.

"You can capture the moment when pathology occurs in the dish in front of your eyes. If you know how the disease starts, you might be able to prevent it." **Clare Wilson**

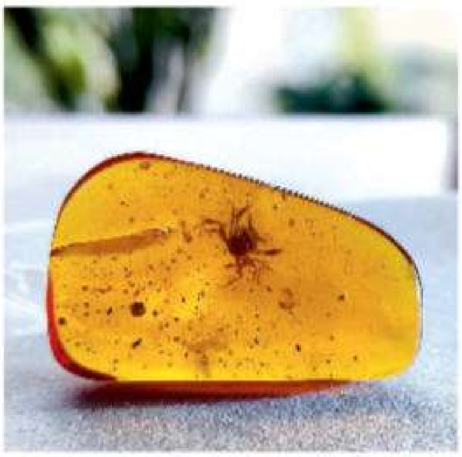
Palaeontology

Get face to face with a crab from dino age

A TINY crab is the first to be found trapped in amber from the dinosaur era. It lived in south-east Asia 99 million years ago.

Remarkably similar to modern crabs, the 5-millimetre-long crustacean is fully preserved, making it "the most complete crab [fossil] ever discovered", says Javier Luque at Harvard University.

This new specimen, in amber mined recently in Myanmar, fills important knowledge gaps about how crabs – including those that can walk on land or live in freshwater – evolved.



LIDA XING

Although molecular estimates set the origins of non-marine crabs at about 130 million years ago, we hadn't found any evidence of such crabs beyond 75 million years ago. Because the fossil, named *Cretapsara athanata*, appears to be a freshwater crab, it potentially extends the record of the group back almost 25 million years (*Science Advances*, doi.org/g3hd).

Luque and his team analysed the specimen under a standard microscope and X-ray micro-CT scanner. They identified the animal's eyes, antennae, pincers, mouthparts, fine hairs and all eight legs. The crab's gills suggest it mostly lived in water. So how did it end up caught in tree resin?

One possibility is that the crab was making a brief, land-based journey between two bodies of water when it got trapped, says Luque. **Christa Lesté-Lasserre**

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Really brief

SHUTTERSTOCK/TUNATURA

Quick saliva test can reveal cannabis use

It is possible to tell whether someone has consumed cannabis within the past 12 hours with a saliva test that detects THC, the main psychoactive component of the drug. Each test would cost just £3.60 once commercialised (*Science Translational Medicine*, doi.org/g3hn).

Elephants evolved due to poaching

Female African elephants in Mozambique evolved to lose their tusks in response to intense ivory poaching that occurred during the 1977 to 1992 civil war. Males retained their tusks because the genetic mutations that lead to tusk loss kill male embryos (*Science*, doi.org/g3hp).

Fossil fuel plans bad news for climate

Collectively, countries around the world plan to extract twice the amount of fossil fuels permitted by the toughest targets of the Paris Agreement, according to an analysis for the UN. In 2030, 110 per cent more fossil fuels will be produced than the Paris deal's target of keeping warming to 1.5°C or below allows, concludes the *Production Gap* report.

Global warming

Airborne plastic slightly cools Earth

TINY bits of plastic in the air may have a minor cooling effect on our climate by reflecting sunlight.

In recent years, microplastics in the atmosphere have been found around the world, with the highest concentrations in the air above London and Beijing. With a size of between 15 and 250 micrometres, about as thick as a strand of hair, airborne microplastics are bigger than most other aerosols in the atmosphere. However, due to their low density, they are easily carried over large distances.

These very small bits of plastic typically come from synthetic textiles, such as polyester, synthetic rubber tyres, paint and larger plastic that breaks up.

Laura Revell at the University of Canterbury in New Zealand and her team investigated the effect of these particles on our climate. They found that the microplastics both reflect sunlight back to space and absorb heat coming from Earth's surface, which means they can cool and warm the climate. However, the team found they have an overall cooling effect, reflecting more heat than they absorb.

But the team also found that this cooling effect is negligible compared with the cooling and warming influences of greenhouse gases and other atmospheric aerosols (*Nature*, doi.org/g3hk).

The concentration of microplastic particles in the atmosphere is several orders of magnitude smaller than other types of atmospheric aerosols, which is why their climate effect is so small, says Revell. **CL**

Materials

BO CHEN

Extra sharp knife is made entirely out of wood

WOODEN knives that are much sharper than steel ones could help us to cut energy use and plastic cutlery waste.

Teng Li at the University of Maryland and his team developed a material called hardened wood that is 23 times harder than raw wood and can be carved to make blades three times sharper than standard steel ones.

The key to these wooden knives is the use of strong cellulose fibres found in plant cell walls, which make up almost half the mass of wood, rather than the weaker polymers in cell walls. The team removed the weaker polymers from raw wood chemically, before compressing the remaining cellulose fibres at a pressure of 20 megapascals for 6 hours and drying them at around 100°C to produce hardened wood. Metal cutlery requires much more energy to produce.

The researchers compared the sharpness of knives made from hardened wood with those made from steel. They found that the wooden knives required around three times less force to slice through a standard electrical wire and felt comparable with steel knives when cutting through a medium well-done steak (*Matter*, doi.org/g3g8). Carissa Wong

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Insects

Ants caught by kids show insect changes

IMPORTANT information about how ant populations are evolving in the face of global warming, forest farming and urbanisation has come from a citizen science project involving hundreds of Danish children.

The children and their families trapped 19,000 ants across Denmark. Comparing the new catches with specimens dating back to 1900, a research team has detected major population shifts in these "hugely important, but vastly underappreciated" insects, says team member Julie Sheard at the University of Copenhagen.

Taking into consideration the year in which historical specimens were captured and their locality, the researchers used modelling to estimate how the geographical range and population size of 29 ant species has changed over the years (*Biology Letters,* doi.org/g3dj).

They discovered that while half of the species have had stable populations since 1900, the other half have either declined, increased or fluctuated, says Sheard. They found jet ants (*Lasius fuliginosus*), European fire ants (*Myrmica rubra*) and two other *Myrmica* species have seen their populations decline, mainly since the 1950s. **CLL**

Towards sustainable biofuels

Christopher Humphreys and Francois Seys: SBRC - Nottingham

Fuels derived from biomass, or biofuels, have the potential to decarbonize sectors which cannot be electrified easily. Coupled with carbon capture technology, some of them could theoretically even become carbon negative.

This still contested possibility is at the core of the strategies of both the EU and the UK to reach Net-zero CO_2 emissions. Biofuels are perhaps an even more important component of energy security: few countries possess oil fields, but all can grow the trees, crops, algae, yeasts and other microbes which are needed for biofuel production.

However, most biofuels commercially available today come with important trade-offs: they occupy valuable land and demand important resources, to the point that their carbon and broader ecological footprint is often questionable. Developing truly sustainable biofuels is thus an important challenge; both for the environment and for our energy security.

SBRC-NOTTINGHAM is a UKRI BBSRC/EPSRC funded, Synthetic Biology Research Centre led by Professor Nigel P. Minton at the University of Nottingham, UK.

SBRC–Nottingham aims to provide new technologies in the form of engineered bacteria and processes that together can be used at scale by industry to transform our energy intensive economy into a sustainable and more carbon neutral bioeconomy.

The Centre is collaborating with industry such as LanzaTech and Deep Branch to optimise and commercialise the production of low carbon fuels, everyday chemicals and animal feed using gas fermentation.

For more information visit:
https://sbrc-nottingham.ac.uk

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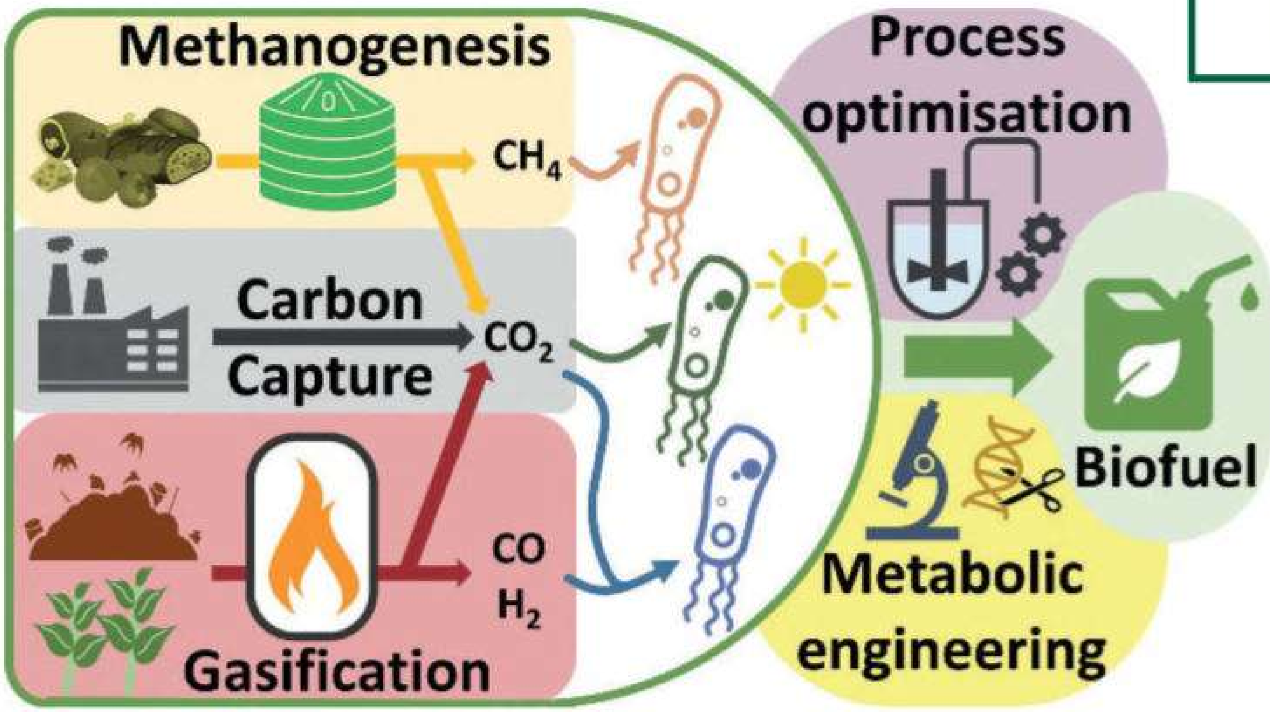


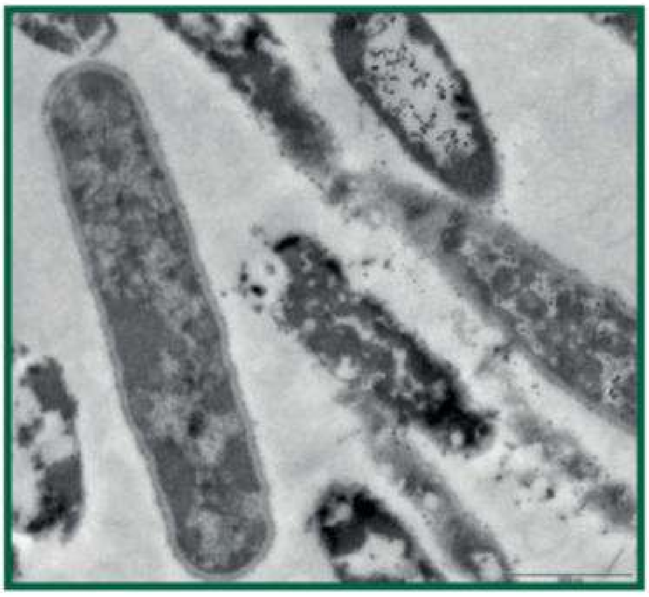
Synthetic Biology uses cutting-edge molecular techniques to engineer microorganisms (*e.g. Clostridia*) which can recycle waste carbon from industrial off-gas and landfill waste into biofuels or other useful chemicals.

They can be grown in tanks which can be built almost anywhere and do not compete for land with agriculture. Methanotrophs help us capture the methane (CH_4) which would have otherwise been released from food waste landfill, whereas autotrophic microorganisms fix carbon dioxide (CO_2) using either sunlight or hydrogen (H_2) as an energy source. These fascinating microbial factories enable the sustainable production of chemicals and fuels while consuming greenhouse gases. They are thus capable allies in our fight against climate change.

About Us

***François Seys** is a research associate at SBRC-Nottingham. His passion for sustainability and synthetic biology led him across Sweden, the USA, and finally in the UK to study next-generation biofuels and biomaterials. He is excited about the potential of gas fermenting organisms to accelerate the sustainability transition and to reduce our dangerous addiction to fossil resources.*

***Christopher Humphreys** is a Senior Research Fellow at SBRC-Nottingham, who has studied in the field of Synthetic Biology and Gas fermentation for the last eight years. His focus is the engineering of microorganisms such that they can be applied to not only produce useful fuels and chemicals, but simultaneously reduce our carbon impact on the planet through the capture of GHG emissions.*



Clostridium autoethanogenum

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The columnist
Annalee Newitz dives into the secrets of the streaming giants p28

Aperture
Art and climate collide in a stunning series of images p30

Letters
Don't let the RNA medical revolution get derailed p32

Culture
What *Frankenstein* tells us about the science of life p35

Culture columnist
Sally Adee is hooked by a series of gothic-tinged sci-fi tales p36

Comment

Mind the meadows

Grasslands are overlooked as a key means of combating global warming. That must change, says **Gill Perkins**

HUMANITY'S connections to grasslands run deep. Our ideas of the perfect habitat lean heavily on the meadow, brimming with bumblebees and butterflies flitting between wild flowers: the perfect idyll. As the 13th-century Persian poet Rumi wrote: "When the soul lies down in that grass, the world is too full to talk about."

Permanent grasslands hold about a third of Earth's terrestrial carbon, meaning they can't be overlooked when we talk about slowing climate change. More grasslands, and especially more biodiverse ones, means more natural carbon storage. Yet instead of expanding these habitats, we risk losing them entirely.

The past 100 years has seen this terrain destroyed on a terrifying scale. Since the beginning of the 20th century, the UK alone has lost at least 97 per cent of its meadows. Tall grass prairie in the US once covered 170 million acres, less than 4 per cent of which survives. Pollinators, such as butterflies and bumblebees, that create and depend on these biodiverse environments are also at risk.

Often, grasslands are seen as empty spaces. They are there to be ploughed and sown and built on. Their destruction isn't met with the same angst as deforestation by the public or politicians. While one of the goals of the COP26 climate conference is the halting of deforestation, there is no such stated aim to protect meadows, savannahs and steppes.

ROBERTO CIGNA

That is why my organisation, the Bumblebee Conservation Trust, has joined a group to push the protection and restoration of species-rich grasslands to the top of the global political agenda. The Grasslands+ coalition will be led by UK charities Plantlife, Butterfly Conservation and the trust I head, and together we will advocate for the symbiosis of plants, pollinators and people.

While we are all familiar with the idea of forests as Earth's "lungs", reforestation isn't the sole or simple solution to the problems we face. Mass planting of trees isn't feasible in many human-inhabited areas of the world, and a lot of land that may have had potential for forestry is ultimately lost to grazing and cultivation. On the other hand, even small mown and grazed meadows contain a greater diversity of flora and fauna than equivalent areas of forest.

At either extreme of grassland management – mown short or left long – there are species that thrive. A mosaic of approaches can aid species in both, as well as those that like something in between.

Even long-grass movements such as Plantlife's "No Mow May" advocate mowing less and at the right time rather than not at all.

This means grasslands can provide an ideal environment for us to enjoy as places to eat, work and play in nature, while also providing the essential functions of carbon sequestration and oxygen-releasing photosynthesis.

One recent study suggests that the cultivation of species-rich grasslands on degraded and deserted farmland, of which there are 430 million hectares globally, could "greatly increase carbon capture and storage rates on degraded and abandoned agricultural land".

It is vital that world leaders at the COP26 summit put international protections for grassland on the agenda, to mitigate the effects of climate change, increase biodiversity and ensure that these areas of natural beauty are preserved for future generations to enjoy. Thousands of our members and supporters are now writing to their elected representatives to demand recognition of these precious places and their essential role in the fight against global warming and biodiversity loss.

It would be tragic if, in the rush for big solutions to our big problems, the power of the modest wild grasses and flowers, with their bumblebees and butterflies, was overlooked. ▮

Gill Perkins is the chief executive of the Bumblebee Conservation Trust

This changes everything

The secretive world of online streaming

The way companies measure "views" online is flawed. Perhaps that is why so much TV is stuck in the past, writes **Annalee Newitz**

Annalee Newitz is a science journalist and author. Their latest novel is *The Future of Another Timeline* and they are the co-host of the Hugo-nominated podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is **techsploitation.com**

AUSTRALIAN comedian Hannah Gadsby recently came up with a pithy description of Netflix: an "amoral algorithm cult". She would know. It was Gadsby's Netflix special *Nanette* that launched her to international fame. She chose to describe the streaming giant in those terms after an anonymous leak revealed details about the company's system for rewarding creators based on algorithmic predictions of audience numbers.

When Netflix makes decisions about what shows to buy or cancel, their executives often cite "the algorithm", an internal tool that crunches data about viewership – and is implicitly more objective than a person. Spoiler alert: the system isn't objective, and its algorithms are making predictions based on skewed data. This isn't just about Netflix though – it is one of many streaming video companies whose audience metrics are increasingly questionable.

The current controversy starts after the release of Dave Chappelle's latest comedy special *The Closer*. Instead of his usual social satire, Chappelle delivers what sounds like cable news commentary about how gay and transgender people are ruining everything. Not only did many viewers find it needlessly offensive, it simply wasn't funny.

Amid demands that Netflix remove the special, a leak revealed that Chappelle's previous special, *Sticks & Stones*, had, at $23.6 million, cost more than the current hit drama *Squid Game*. At the same time, the comedy special scored much lower than this series on a key audience metric called "adjusted view share" – a measure of return on investment, based on whether audience engagement justified the cost.

Netflix executives say they use algorithms and data to decide which shows to commission and how much to pay for them. But these latest revelations make it look like Netflix paid even more for *The Closer*, even though it knew that Chappelle's previous special had underperformed. What kind of ass-backwards algorithm would recommend paying more for a show whose predecessor hadn't lived up to expectations?

This question has opened a larger debate about how popularity is measured in the secretive world of streaming video. Netflix is famous for making barely any of its viewership numbers public, despite prominently displaying a "top 10" shows on a carousel on its front page. It isn't alone. It is impossible to get solid viewership numbers on Amazon-produced shows or other streaming services like Disney+ and YouTube.

> **"When companies do reveal how they come up with audience metrics, the reasoning often sounds bonkers"**

Even when companies do reveal how they come up with audience metrics, their reasoning often sounds bonkers. Netflix now releases viewership data for many popular shows, but includes users in that data even if they have only watched the first 2 minutes of a single episode.

I watched the first 2 minutes of *Squid Game* and I didn't even make it through the opening credits, yet Netflix can now add my "view" to its audience data. Meanwhile, Facebook claims that a video has been viewed if a person watches it for 3 seconds or more. YouTube is a bit more generous, calling it a "view" if someone watches for 30 seconds after deliberately pushing play.

Though all these firms have data on how many people watch videos or series through to the end, they choose not to publicly measure success in those terms. And you can see why: in 2020, Netflix acknowledged that its 2-minute metric is "about 35 percent higher on average than the prior metric", which was based on how many people "watched 70 percent of a single episode of a series".

Netflix has just announced it will begin reporting viewership in terms of the total number of hours watched, too. Still, it is deeply problematic that executives apparently use flawed audience data to help determine what gets green-lit for production and how much money it receives. The algorithm is a shield that executives can use to claim objectivity when in fact they are making decisions exactly like gatekeepers did in the bad old days of the 20th century. They are selecting shows based on their own personal preferences.

Netflix execs are free to make decisions based on whatever they want, of course. The trouble is that they are using their algorithm to make it appear that it isn't entirely their decision. They claim to be reflecting the desires of the masses as expressed in audience views. That makes it somehow our fault that bad shows get green-lit, while potentially good stuff never sees the light of day.

In reality, certain people in the US entertainment industry are cutting deals and promoting the things that they liked 20 years ago when Chappelle was fresh. They may have sparkly new algorithms, but they are still making decisions like it is 1982. ▮

Annalee's week

What I'm reading

The Dawn of Everything *by David Graeber and David Wengrow, a terrific, evidence-based history of humankind that will turn everything you know on its head.*

What I'm watching

Three minutes of every show on Netflix, just to mess with its algorithm.

What I'm working on

Trying to reduce my water consumption by 15 per cent. The California governor has declared a state-wide drought emergency.

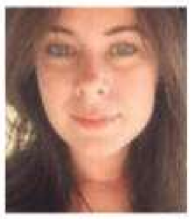
This column appears monthly. Up next week: James Wong

MEDECINS SANS FRONTIERES
DOCTORS WITHOUT BORDERS

Above: An MSF team perform surgery in one of three operating theatres at Boost hospital, Lashkar Gah, Helmand province. *Photograph © Tom Casey*

AFGHAN CRISIS APPEAL

"Fighting in Afghanistan had been intense since May, but in August the situation got progressively worse."



SARAH LEAHY
PROJECT COORDINATOR

"For a time, the frontlines ran right by our hospital in Lashkar Gah.

We were located in between strategic buildings and rockets would be going over the hospital, explosions occurring and bullets hitting the buildings all the time. We were exposed to the crossfire and twice we were hit by rockets.

It was very intense, but through all the fighting we carried on working. It's a huge hospital, one of MSF's biggest projects, and is an absolute lifeline in Helmand province. We have nearly 1,000 Afghan staff, an emergency room where we treat more than 500 patients a day and a maternity ward with an average of 60 deliveries a day.

During the fighting we were getting 30 to 40 people in for surgery each day with bullet wounds and injuries from shelling and explosions.

Many people who needed medical care struggled to reach us. People were forced to wait at home until the fighting subsided, while others were caught up in crossfire on their way to hospital. People would be coming to see us for pneumonia, then get caught up in the fighting and arrive with a bullet in the shoulder or the leg. Roads and bridges had been bombed, so what should have been a 40-minute journey to hospital took four hours. There was no fuel, but people were coming on foot from all over the province, on pushbikes with pregnant women, all in 48-degree heat.

The health system in Afghanistan has essentially collapsed. It wasn't in great shape in the first place, but now the situation is desperate. That's why it's so important that MSF is still there, conducting surgeries, helping women give birth, giving people the basic, lifesaving healthcare that they need. It's vital that Afghanistan and the people who need our help are not forgotten."

Since the change of government in August, our teams have continued providing medical care to the people of Afghanistan. In five locations across the country, our teams are treating emergency trauma cases and providing lifesaving medical care.

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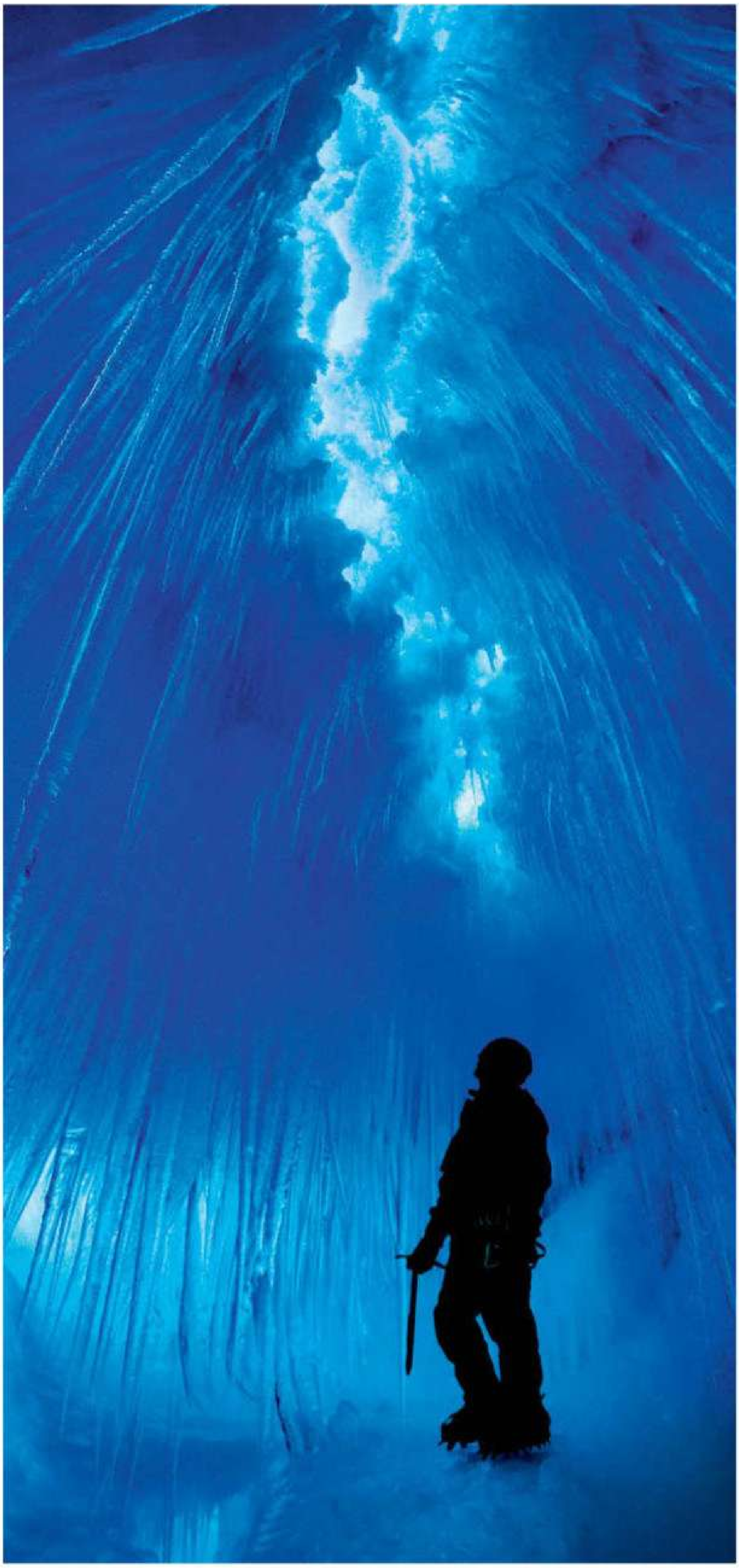

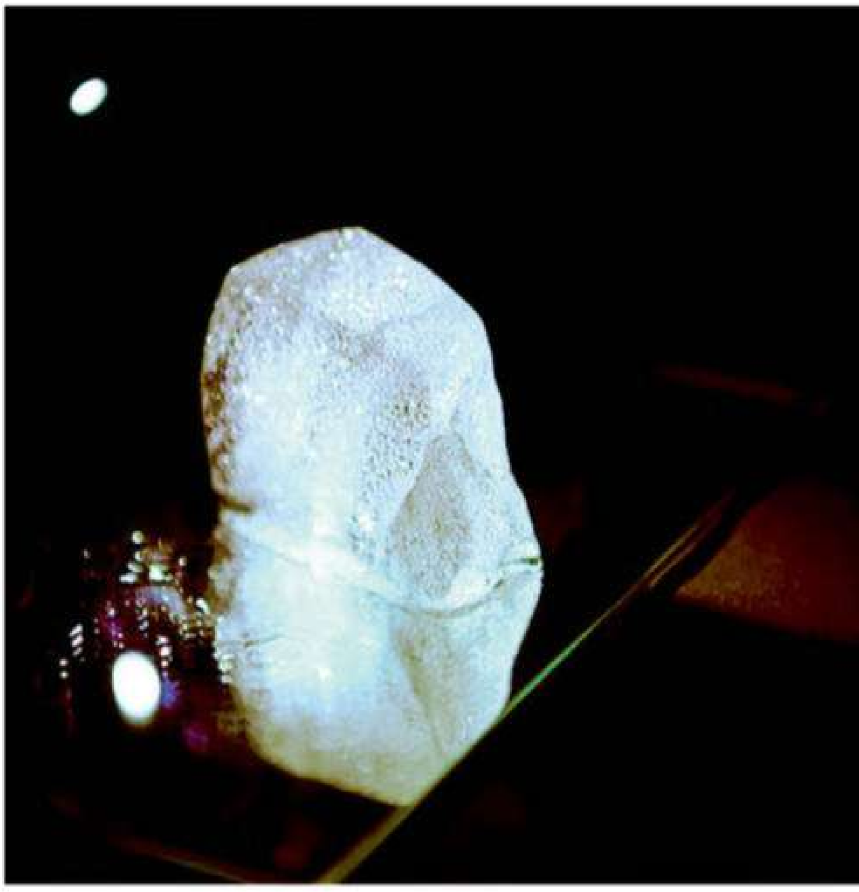

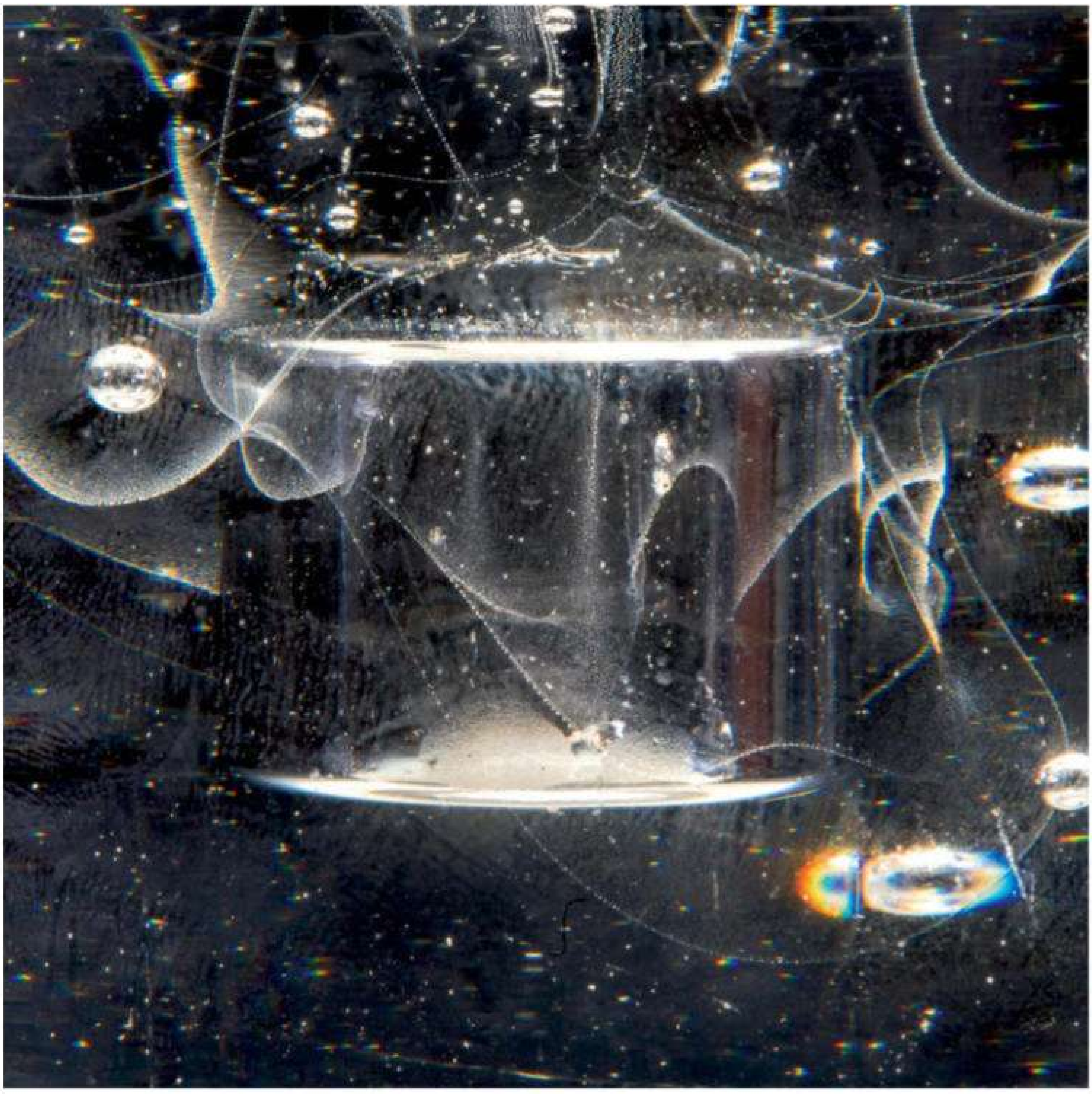

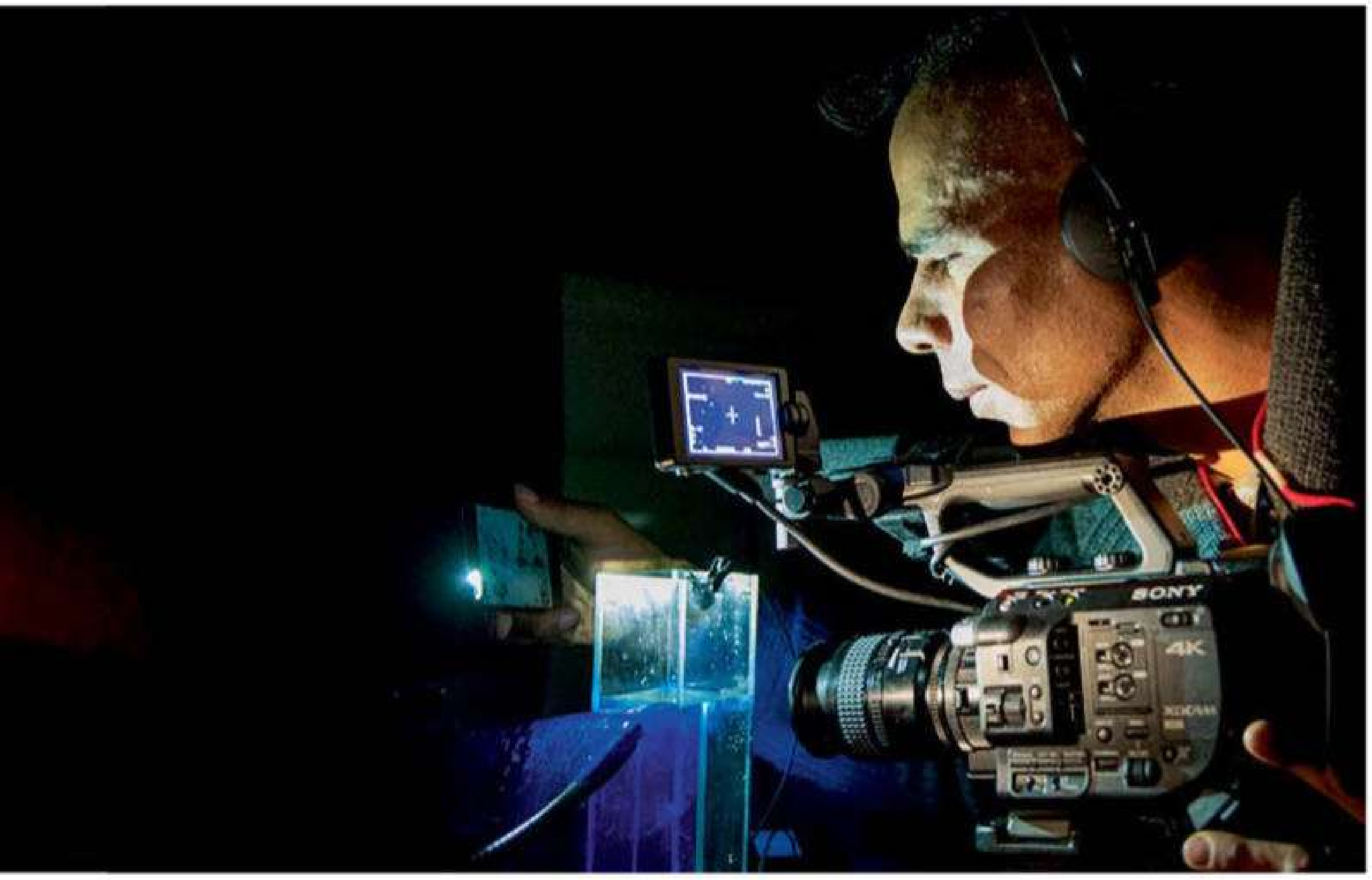

Ice cool

Photographer Pete Bucktrout/ British Antarctic Survey

THESE captivating images encapsulate the past, present and future of the global climate. They provide a taste of what's on show at Polar Zero, an art and science exhibition designed by artist Wayne Binitie to complement the COP26 summit on climate change in Glasgow, UK (see page 8).

One of the exhibition's highlights is a sample of ice from the Antarctic (top centre). Known as an ice core, these are collected by drilling deep into the ice – and hence back in time. They allow scientists to study past climates and atmospheres, for example by examining the trapped air bubbles that formed when snow fell on the ice. Analysing the amount of carbon dioxide in such bubbles reveals its rising levels in the atmosphere.

Top right is a close-up shot of *1765 'Air'*, a glass sculpture that contains an ampule of preserved Antarctic air from 1765 – a year sometimes said to have marked the dawn of the industrial revolution and a crucial turning point when human activity began to warm the planet.

Another of the exhibition's elements is Ice Stories, a mix of images, text and other documents drawing on the anecdotes of those working at the poles. The image at the far left shows a scientist in an ice crevasse in Antarctica.

The exhibition's centrepieces were designed by Binitie, who can be seen in the bottom image filming ice bubbles.

Polar Zero – a collaboration between the British Antarctic Survey, the Royal College of Art in London and engineering firm Arup – is at the Glasgow Science Centre until 12 November. ▮

Gege Li

Editor's pick

This medical revolution must keep public onside

16 October, p 38

From Robert Peck, York, UK

Michael Le Page makes very good points on the promises of mRNA therapies. But as with so many new technologies, what is crucial at this point is public perception. Look how fearful so many people are of nuclear power despite its excellent safety record, simply due to other technologies that were developed from nuclear physics breakthroughs in the same decade. We must be very careful not to jeopardise the reputation of mRNA.

No time to waste in tackling climate change

9 October, p 34

From Bruce Denness,
Niton, Isle of Wight, UK

The Intergovernmental Panel on Climate Change's conclusion that "we will reach 1.5°C of warming within the next 20 years" seems both optimistic and fanciful.

The predictions of a climate model I was involved with, which successfully forecast the rise in warming in the 1990s and the hiatus since 2015, foresees a sharp spike in warming beyond 2030. This makes the IPCC's timescale for modest action appear at best misguided and, more realistically, woefully inadequate.

Anonymity will only give fraudsters free rein

Letters, 16 October

From Andrew Tyrtania,
Lidlington, Bedfordshire, UK

Sam Edge, while taking aim at the adoption of cryptocurrencies by some countries, writes: "Yes, there is a need to maintain the ability to perform anonymous transactions in a free society."

I disagree wholeheartedly. Privacy maybe, but anonymity, never. The fight against financial crime is relentless and weak. Aid money doesn't get to where it is intended and people trafficking, exploitation, bribery and corruption continue to flourish. The sooner we move to a global cashless society the better. This needn't disempower the least fortunate. Quite the opposite effect is possible.

Removing privacy, which is rarely morally defensible, will help create meaningful redistribution of wealth from rich to poor.

Lunar trenches may be best sign of black holes

2 October, p 46

From Tom Potts,
Holsworthy, Devon, UK

Surely the best indicator of any impacts of primordial black holes on the moon would be those resulting from grazing collisions. Grazing meteorites explode or bounce off, leaving teardrop or repeated impact craters. Small black holes impacting in this way could create continuous linear furrows, possibly leading to tunnels that may collapse at a later date. These would be unique to black holes and long-lasting on the moon or other airless bodies.

Big not always better when it comes to Olympic glory

Letters, 2 October

From Duncan Cameron,
Brighton, East Sussex, UK

Sonia Novo writes that the results of the Tokyo Olympics demonstrate a "stark representation of the inequalities of the world".

Looked at a different way, however, the real champions are the Bahamas, Jamaica and New Zealand, which each gained one medal per 300,000 people or less. On those terms, this is a much better performance than China, which only managed one medal per 16.9 million people. The US gained only one medal per 2.9 million people.

Ending pandemic top-up payments will have impact

16 October, p 17

From Geoff Harding,
Sydney, Australia

The article regarding the likely consequences of UK government benefit cuts to poorer families could equally well have been written about Australia, where the imminent termination of government top-up payments is expected to drive significantly more children into poverty.

Governments should understand that there are many bright children who could do much for their country, but will have both their long-term health and educational prospects severely prejudiced by a childhood in poverty. Continuation post-pandemic of the extra payments to families should be an essential investment for the future.

From Eric Kvaalen,
Les Essarts-le-Roi, France

You tell us how many more children will suffer from a list of ill effects when the UK government stops giving out £20 a week in top-up payments. The UK should start giving £40 a week, and you'll have exactly the opposite result.

Non-genetic engineering ways to make bread better

2 October, p 9

From William Hughes-Games,
Waipara, New Zealand

I suppose it is good that wheat has been engineered using CRISPR gene editing to contain less carcinogenic acrylamide, but there are far simpler, less exotic ways of making this foodstuff better for our health and, at the same time, more nutritious.

We should stop treating wheat with pesticides just before harvest and with insecticide during storage. In addition, grind your own flour to ensure full nutrient content and make sourdough or sprouted-grain bread. This lowers levels of phytic acid, which inhibits uptake of minerals from the meal you eat with bread. Surely a nutritious diet is the first, most important step in avoiding cancer.

The great heat pump debate rumbles on

Letters, 9 October

From Ben Craven, Edinburgh, UK

Rachael Padman writes that the advantages of heat pumps over direct electrical heating will decrease as we decarbonise the electricity supply and green power becomes plentiful.

While renewables may produce no carbon dioxide, they have side effects. To heat a home with electric resistance heating when we could use half as much power by using a heat pump isn't the way forward. We need to be as frugal with renewables as we should have been with fossil fuels.

AI wars will be too fast for humans to comprehend

2 October, p 14

From David Tossell, Portishead, UK

The idea that robotic weapons must be subject to human control presupposes we have that luxury. The reality is that having a human in the loop will be too slow if up against a fully automated foe. The latter will perform according to its preloaded algorithms in a similar manner to automated trading on the stock exchange. The role of "human control" will be in the creation of those algorithms. Under these conditions, should war break out, it will occur at a pace no human can comprehend.

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The world of tomorrow

Sci-fi writer Kim Stanley Robinson discusses his latest novel's powerful vision of our climate future with **Adam Vaughan**

ONEINCHPUNCH/ALAMY

The fightback against climate change is an all-hands-on-deck situation

"EVERYTHING is happening way faster than it happens in *The Ministry for the Future,*" says Kim Stanley Robinson of his latest novel, set in a world where an international agency is tasked with fighting for future generations on climate change. That vision was imagined mostly in 2018, which the US science fiction writer says now feels like "another geological age" because so much has happened, from Donald Trump's election defeat to the covid-19 pandemic.

"Climate change seems to be the main topic on the table now, with all the storms, droughts, fires, freezings – the climate weirdness that has begun and looks like it will never cease in our lifetimes," he says. Stanley Robinson – or Stan as he is often known – has repeatedly tackled climate change in his work, which is studded with heroic scientists and nods to scientific papers. His focus has increasingly moved beyond the problem of a rapidly warming world to what we should do about it. *New York 2140*, his 2017 novel, is a salutary warning of the risk of a drowned world if free market economics keep trumping the environment.

The Ministry for the Future hops from Switzerland to India and Antarctica as it mulls every climate fix imaginable, from the titular agency to legal and financial incentives, all the way to activists who are so desperate that they resort to extremism.

Real-world versions of the ministry, such as Wales's future generations commissioner, have suffered from a lack of clout. Does Stanley Robinson think his fictional one would work in reality?

"It would be a great thing, but it wouldn't be simple or in any way easy to incorporate, because we're so present-orientated," he says. Moreover, it would be no panacea. "People would love to have the idea of a single fix, one thing will make everything right," he says. "That's just not going to happen."

Nor is he comfortable with the answer being violent extremism and illegal "black ops", which some of the book's characters resort to. "I'm sure that there's going to be people around the world who are really angry in coming decades and they will commit violence hoping to make a better situation, calling it resistance," he says. "I think it would be better if we managed to forestall that with legal reforms that are really fast."

SEAN CURTIN

Kim Stanley Robinson uses climate science as inspiration for his novels

So where does hope lie? In top-down efforts such as international diplomacy, in grassroots local efforts by citizens and everything in between, says Stanley Robinson. "It's an all-hands-on-deck situation. The idea of either/or, or one's better, one's worse, all that needs to be thrown over the side," he says. It is for this reason that Stanley Robinson thinks research into geoengineering methods, such as temporarily reducing the amount of the sun's energy reaching Earth, is worth pursuing. All that matters is what works and is fast, he says.

He is also clear that our economic systems need reform. "It's one of the reasons we aren't reacting faster [on climate] than we are, because we're locked into an ineffective system," he says.

Stanley Robinson thinks the "capacious" nature of novels makes the form good at tackling the subject of climate change. He says its two strengths are giving readers time travel – "you are suddenly in a different time and space and really living it" – and telepathy. "You are in someone else's head," he says. But there are limits.

"You can only push a novel so far. I don't even believe in futurism or futurology – I'm a novelist."

Yet he follows new science more closely than most novelists. The Intergovernmental Panel on Climate Change's recent report on the state of climate change science was "the ultimate in alarms going off", he says. "The scientific community has been ringing that alarm since the late 90s. And the response has been slow and the resistance has been high." But he fears the warning is being drowned by the noise of others, from pandemic disruption to "so-called political divides", he says.

One of Stanley Robinson's worries is a real-world equivalent of the deadly heatwave that opens his latest novel. "I fear that something like that is going to happen," he says. He suspects such an event might topple a government but fail to affect global action. "The rest of the world will say, 'oh, that's what happens in the tropics'. We're very good at ignoring stuff that happens elsewhere and saying 'it can't happen to me'."

Stanley Robinson says he sees opportunity at the COP26 climate summit in Glasgow, UK, where he will give a speech. "My hopes are high COP26 will come up with something striking. Progress will be made." He is also a big fan of US president Joe Biden. "He has been surprisingly good on climate. And I say this as a leftist."

And what next? More climate change-themed novels are in the offing. Stanley Robinson has already written novels set in Antarctica, including *The Ministry for the Future*, and now he wants to head to the other pole. "I'm looking at the Arctic – can we keep an ice sheet over the Arctic? It's so important," he says. If the idea grows into a story, it will explore a melting Arctic's impact on governance, ecology and culture, not to mention the global climate as the region's reflectivity changes.

> **"You can only push a novel so far. I don't believe in futurism or futurology – I'm a novelist"**

Sixteen years ago, Stanley Robinson told *New Scientist* he liked novels with happy endings. Does he hope for one on climate change? "We could have a good 21st century, we could have a good dealing with climate change, we could have a good Anthropocene," he says. "This is what I charge the young science fiction writers with: you have to write that story so people can imagine it in advance – and then try for it." ▮

The Ministry for the Future is out now in paperback. Turn to page 47 for more on climate protest

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Sparks of life

A classic monster was born from a new view of life and death, finds **Simon Ings**

Book

The Science of Life and Death in Frankenstein

Sharon Ruston

Bodleian Library Publishing

GRANGER HISTORICAL PICTURE ARCHIVE/ALAMY

The 1939 film *Son of Frankenstein* starred Boris Karloff and Basil Rathbone

IN 1817, the natural philosopher Karl August Weinhold removed the brain from a living kitten and replaced it with a mix of zinc and silver, essentially a battery. According to Weinhold, the animal "opened its eyes, looked straight ahead with a glazed expression… hobbled about, and then fell down exhausted".

The following year, Mary Shelley's *Frankenstein* was published to a public hungry for the author's take on one of the most pressing scientific issues of the day: is electricity the key to animal life? And if so, can a short sharp jolt reanimate the dead?

Recent history had blurred the once a clear divide between life and death. There were reports of flickers of what looked like life in freshly guillotined heads in revolutionary France, and the invention of mouth-to-mouth resuscitation allowed people who had seemingly drowned to spring back to life.

Sharon Ruston covers this historical ground well, and takes it further, revealing Shelley's firm grip on the scientific issues of her day – in particular, the growing understanding of the role of electricity in life.

In the last decades of the 1700s, it was believed that animal life was driven by something called animal electricity, thought to be distinct from the kind that flows through metal. The idea came from the physician Luigi Galvani to explain why the muscles in the legs of dead frogs twitched when hit by an electrical spark.

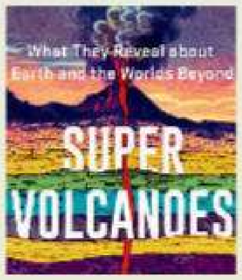
Galvani's nephew, Giovanni Aldini, took these experiments further in theatrical events in which a current was passed through corpses. The bodies then opened their eyes, clenched their fists, raised their arms, beat their hands against the table or moved as though attempting to stand or sit up.

As Ruston writes, in Shelley's book, Victor Frankenstein's anguished description of the moment his Creature awakes "sounds very like the description of Aldini's attempts to resuscitate 26-year-old George Forster", one of the corpses experimented on after he was hanged for the murder of his wife and child in 1803.

***The Science of Life and Death in Frankenstein* is both a great introduction and a serious contribution to understanding *Frankenstein*. Through Ruston's eyes, we see how the first sci-fi novel captured the imagination of a science-hungry public.** ▮

Simon Ings is a writer based in London

Don't miss



Read

Super Volcanoes sculpt the sea, land and sky, and alter the machinery of life. Join science writer Robin George Andrews on a journey from Yellowstone, Tanzania and the ocean floor on Earth to the moon, Venus and Mars.

Watch

Finch stars Tom Hanks as a lone survivor on a post-apocalyptic Earth. Caleb Landry Jones plays his robot, built to care for Finch's dog if the worst happens. It is a drama about love, friendship and the essence of being human. On Apple TV+ from 5 November.

DUST TO DATA, COURTESY OF LARRY ACHIAMPONG AND DAVID BLANDY

Visit

Future Ages Will Wonder explores how science and technology write the history of the future, including *Dust to Data*, a CGI exploration of what we mean by civilisation (pictured). At FACT Liverpool in the UK until 20 February.

The sci-fi column

Dark tales, weird worlds Aliya Whiteley's gothic horror-tinged sci-fi makes you strain to see what she's hiding. But beware: the stories, and their unlikely heroes, will creep into your bones in the process, says **Sally Adee**

Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally_adee

Book

From the Neck Up

Aliya Whiteley

Titan Books

Sally also recommends...

Books

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PHOTOALTO/NEVILLE MOUNTFORD-HOAR/GETTY IMAGES

In one dystopian vision, fruit and vegetables are grown only for the rich

IN 1968, the horror movie *Rosemary's Baby* brought a canny cinematic trick into the world. At a particularly ominous juncture in the film, director Roman Polanski wanted to frame a shot of Minnie Castevet – the increasingly suspect neighbour – as she sneaks into Rosemary's bedroom. In what turned out to be a stroke of genius, Polanski shifted the camera until only a sliver of Minnie's back remained in the frame, barely visible through the doorway.

During the test screening, the entire audience reportedly craned their necks and leaned to the side in a vain attempt to see what she was doing. This is a fair approximation of how it feels to read the stories in Aliya Whiteley's new collection *From the Neck Up*.

The first of these weird and wonderful tales is set in a high-tech, high-security agricultural biodome, where elderly conscripts are growing fruit and vegetables to sell to rich people after the Gulf Stream collapsed, unleashing freezing conditions. This neat arrangement seems to be going well. Then, the poor, needy and angry break into the dome.

Another story is about refugees from a future war who colonise a vast patch of floating garbage in the Pacific and gain the ability to eat radioactive plastic detritus.

A third features an alien invasion that is so far beyond human understanding that no one can articulate what is happening, even as humankind is picked off one by one.

> **"Whiteley's gothic-inflected science fiction is icy and remote and you can't look away"**

Then there is the story of an emerging global sensory phenomenon that no one can adequately describe, but that people are inexorably drawn to even as it seems to have horrific medical consequences.

Alien invasions, dystopian climates, future wars: on the surface, these are the bread and butter of science fiction, but the way Whiteley has written them doesn't slot easily into the genre. She gets put on lists with Henry James and Shirley Jackson. She was up for an award named for the latter, and for good reason: her gothic-inflected science fiction is icy and remote and you can't look away. But more in the style of Polanski, it convinces you to persist in the irrational faith that this time, in this short story, she will let you peer behind the veil.

What does she want you to see? One clue is in the age of her protagonists – nearly all of them old, near death, or watching their lives accelerate towards an end. Stories about getting old fall into strange territory: one where we may not feel comfortable with the reality that it will happen to us.

For many of us, ageing is both science fiction (something that will happen in a future too distant to care about) and gothic horror (it's coming, and it will be awful).

In this way, old age is a little like obscenity: impossible to define, but you know it when you see it, and then you want to look away.

Whiteley is writing about the unexplored territory that no one wants to visit, and has grasped that there is one sure-fire way to hook us: by holding back the details and forcing us to peer in.

If this all sounds like a hard slog, it is anything but. The other overarching feeling I got from the book is the dread of each story ending. Whiteley's worlds may be icy and gothic, but the people in them are altogether human, and their funny and cantankerous inner lives make them good company. You will miss these grumpy old people: they're getting too old for this shit, but so, I would wager, are you. ▮

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The vegan health illusion

Veganism is equated with healthy eating, but look closely enough and you might be surprised at what you'll find in plant-based alternatives, discovers **Helen Thomson**

DONALD Watson was born in Yorkshire and spent much of his youth on his uncle's farm. But rather than making him feel at ease with breeding animals for food, the realisation that these "friendly creatures" went for slaughter horrified him. He became a vegetarian in 1924, aged 14. Two decades later, with his wife and four friends, he coined the word vegan from the first and last parts of the word vegetarian, and founded the UK Vegan Society.

Watson's diet was filled mostly with nuts, apples, dried fruit, vegetables and, when wartime rations allowed it, lentils. Fast-forward to today, and Watson would have been astonished at the wealth of vegan-friendly offerings. Browse the aisles of supermarkets in the UK, US, Australia and beyond and you will find a growing amount of space dedicated to vegan fish and meat alternatives. But while Watson's diet turned out to be a healthy one, a different picture is emerging for some of today's vegans.

Take a look at the ingredients in the ever-increasing variety of products and they can seem more like junk, packed full of salt and ingredients such as "soya protein concentrate" that you wouldn't find in a chunk of meat.

While today's factory-produced foods make it easy to switch to a vegan diet without the need to make drastic changes to eating patterns, these alternatives might be worse for our health than the meat versions they are replacing. Finding out is increasingly important, due to the growing number of people avoiding meat and dairy in their diet. So what do we – and don't we – know?

When Watson applied for vegan rations during the second world war (a request that was ultimately denied), there were just 35 members of the Vegan Society. This year, more than half a million people signed up to take a month off from eating animal products in the UK for "Veganuary", and nearly 3 per cent of people in the US avoid eating such products.

Today's vegans can have motives beyond the original concerns about animal cruelty that led to plant-based diets. Some are driven by environmental factors, such as the heavy toll of the greenhouse gases produced by the livestock industry. That isn't to say that plant-based foods don't damage the environment. It can take more water to grow nuts, for instance, than to produce the same weight of beef. Yet overall, even the lowest-impact animal-based foods are worse for the environment than plant-based substitutes.

Health can be another motivator. Although critics of early vegans didn't think it was possible to thrive on a diet without meat and dairy, this way of eating has proved to be good for health too, especially since consumption of red and processed meats is now known to increase the risk of developing several cancers. Sure, vegans must ensure they get nutrients that are typically derived chiefly from animal products, such as omega-3 fatty acids, iron and vitamin B12, but studies have shown that a plant-based diet can help you lose weight, lower your cholesterol, reduce your risk of cancer and even add a few years to your life.

Yet with the rise in popularity of veganism has come the rise in fuss-free, vegan meat alternatives, such as "no chicken" Kievs, fake bacon and even plant-based shawarma for late-night doner kebab cravings. Now, 1 in 6 food products launched in the UK are vegan.

"When I first cut meat out of my diet, I'd be

IMAGE BY KYLE BEAN

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cooking my own lentils, a bit of soy mince, loads of vegetables," says Clare Thornton-Wood, a dietician and spokesperson for the British Dietetic Association. "Now you've got vegan chicken nuggets, vegan burgers, vegan sausages. The plant-based movement has put all this processed food into people's diets."

If you are worried about health, there are three things to consider when you buy these products, says Michael Clark at the University of Oxford. "What's in them, what's not in them and what you are swapping them for."

Let's start with what's in them. As Thornton-Wood points out, plant-based meat alternatives are processed foods, that is, they have been altered in some way from their natural state. Not all processed foods are bad. Technically, a pack of vegetable sticks is processed because the carrots have been washed, chopped and packaged. But ultra-processed food often has many unhealthy ingredients added for flavour and texture, such as sugar, fat and salt.

Meaty replicas

The meat-alternative market is rife with these additives, in part because they help replicate the flavour or texture of real meat. "Just like processed meat foods, many plant-based meat alternatives are rather high in salt," says Tom Sanders at King's College London. For instance, a 2018 survey by UK advocate group Action On Salt found that meat-free burgers contain more salt on average than meat burgers. Too much salt contributes to raised blood pressure and increased risk of heart disease and stroke.

Soya is a prominent feature of meat alternatives, too. Although it has a high nutritional quality – it is considered a "complete" protein, which means it contains ample essential amino acids and has a nutritional value roughly equivalent to animal protein – it is also a controversial ingredient.

The soya in processed food comes from soya beans, which can be turned into textured soya protein or soya concentrate. An increasing body of research suggests that soya protein could be beneficial to health, with claims ranging from its ability to fight obesity and ward off osteoporosis to even protect against diseases such as prostate cancer due to the presence of compounds called isoflavones that act like oestrogen in the body. However, there is also research showing that this oestrogen-like effect may have some negative impacts in some people, such as women with breast cancer. A consensus on its

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The truth about plant-based dairy

Head to your nearest coffee shop and you might hear orders for drinks with soya milk, oat milk or even pea milk.

The milk alternative market has exploded in recent years, doubling its sales globally between 2009 and 2015. Meanwhile, cow's milk sales have decreased from $19 billion in 2013 to less than $16 billion in 2018, according to market research firm Mintel. But are alternative milk products good for you?

"Milk" is actually a controversial name for these products. They are in fact extracts from foods like chickpeas, soya beans, oats, almonds, coconut and rice suspended in water. If they are your chosen beverage, you should be aware that some vital nutrients that are in dairy milk can be lacking in plant milks.

They are generally much lower in protein, vitamin B12 and iodine, plus other vitamins and essential nutrients, says Clare Thornton-Wood at the British Dietetic Association. Plant milks can be fortified to make up for some of this, but that isn't always the case. In the UK and EU, for example, the rules for organic status don't permit the addition of calcium.

"A lot of people don't realise that the nutrient profile of alternative milks can be quite different to dairy milks," she says.

It is a similar story for cheese alternatives. Most vegan cheeses – typically made from soya, nuts and vegetable or coconut oils – are high in salt and fat, just like regular cheeses, but without many of the useful nutrients. "So, in a way, you're getting the bad stuff, but not the benefits," she says.

overall health benefits is hard to come by.

One particular health claim that has received a great deal of attention is soya protein's possible role in reducing heart disease by cutting the amount of heart-damaging, low-density lipoprotein cholesterol. In 1999, the US Food and Drug Administration allowed manufacturers of products that contained more than 6.25 grams of soya protein per serving to make health claims about its ability to lower the risk of coronary heart disease, based on a significant number of studies. However, in 2017 it made a proposal to revoke this rule after a review of more recent evidence in which it decided that there was no longer significant scientific agreement to support the health claim.

According to Kristina Petersen at Pennsylvania State University, part of the confusion stems from processed foods. Research shows that plant-based diets that include unprocessed nuts, seeds, fruits, vegetables and legumes do indeed lead to a substantially lower risk of heart disease. What is problematic is that soya protein is now a key ingredient in many ultra-processed foods, and the health impacts of these are unequivocal due to other ingredients: they are bad for us.

> **"Vegans who eat a lot of ultra-processed food are more likely to be obese"**

Two recent studies from France and Spain show that ultra-processed foods are associated with an increased risk of mortality and cardiovascular disease. The Spanish study showed that people who ate more than four servings of processed foods a day increased their risk of early death by 62 per cent.

So although soya protein may, in isolation, appear to be healthy, when it is in a factory-produced meat alternative this may not be the case. Revoking the health claims on products containing soya, therefore, might be necessary to address the problem of its use in ultra-processed foods that can then be labelled as healthy, despite ultimately being bad for us, writes Petersen in the *Journal of the American Heart Association*.

To get a full picture of the health impact of meat alternatives, it is also important to know who is buying these products. To find out, Joséphine Gehring at the University of Paris-North, France, and her colleagues studied the diets of more than 21,000 people, including meat eaters, pescatarians, vegetarians and vegans, and discovered a gold mine of detail, which at first glance can seem contradictory.

Health risks

They found that the nutritional quality of diets was generally higher for vegans than meat eaters. However, they also found that the more people avoided animal-based foods, the greater their consumption of ultra-processed foods, with these supplying 33 per cent of energy intake for meat eaters compared with almost 40 per cent for vegans. In addition, those who had become vegan most recently, or who were younger, had the highest consumption of processed foods. Gehring and her colleagues say that a vegan's consumption of processed food might outweigh the health benefits suggested in previous studies.

Vegans in the study who ate a lot of ultra-processed food were more likely to be overweight or obese, says co-author Benjamin Alles, also at the University of Paris-North. "The 'health halo' typically associated with a vegan or plant-based diet no longer applies to individuals who follow these diets but include a high contribution of ultra-processed plant-based food," he says.

This trend for vegans to consume highly processed food is backed up by a 2017 study on the diets of Italian adults, which found, contrary to expectations, no difference in

HOLLIE ADAMS/GETTY IMAGES

Vegan meat substitutes now look more like the real thing

the environmental impact of the diet of vegetarians and vegans, probably partly due to the consumption of "industrially highly-processed plant-based meat and dairy substitutes".

What about other additives that are used to replicate the taste and texture of meat in plant-based alternatives? Here, you can probably rest easy. While you may not recognise all of the ingredients in these products, any additive you find in your food is approved, which means it is safe to eat. "There is a misguided perception that food additives are harmful," says Sanders. However, what is deemed "safe" can change. For instance, the safety of the additive titanium dioxide, used to whiten foods, has been questioned by the European Food Safety Authority.

Aside from what is in meat alternatives, it is important to think about what's not in them, says Thornton-Wood. "I think a lot of people have jumped on the vegan bandwagon for the sustainability side of it, but they haven't necessarily done the background research to work out how they're going to get everything they need from their diet."

If you are eating a lot of vegan foods, you need to make sure that you aren't missing out on the essential nutrients that omnivores typically obtain from meat, dairy and fish, such as iron, B12, omega-3 and calcium (see "The truth about plant-based dairy", left). While some ready-made vegan products are of high nutritional quality, others are mainly composed of substances such as starch and the sugar trehalose, along with some colouring agents and flavourings.

The third consideration is whether meat alternatives are better or worse than what a person may have been eating otherwise, says Clark. "Some people might be substituting a healthy, home-cooked meal for a processed meat alternative. Sometimes eating vegan products might be a healthy substitution, sometimes not," he says.

If you are eating a balanced diet with the odd processed meat alternative, it is likely that many of the health benefits of being vegan remain. Dietary fibre, which is found only in plant foods, plays a key role in improving insulin and glucose response in the body, helping to prevent diabetes.

Vegan diets also play a significant role in shifting gut microbiota to a population that appears to improve blood glucose levels and reduce body weight. These benefits are unlikely to go away completely, but they may be affected by a heavy intake of highly processed plant-based foods, says Thornton-Wood. In the end, common sense and balance are probably the best bet – as with most dietary advice. "If you eat meat alternatives one or two times a week, that's probably fine, but if you eat fake sausages every day, that's probably not going to be very healthy," she says.

We need a better answer on all of this, says Clark. "With other diets that have been around for decades, we have been able to take surveys from thousands of people and say 'these people who eat this diet are healthier in this way'. We've not been able to do that yet for plant-based meat and dairy alternatives. Until we have those studies, there's going to be uncertainty around the nutritional value of them."

Donald Watson certainly thrived without dairy and meat. He died in 2006 aged 95, apparently delighted to have proved his detractors wrong about the possibility of living well without consuming animal products. But if he had lived on industrially produced vegan food, it might have been a different story. Although adopting a vegan diet avoids the downsides of heavy meat and dairy consumption, if you are filling up on ultra-processed alternatives, you may be missing a trick.

As Thornton-Wood says: "Today, being a vegan doesn't automatically mean you're eating a healthy diet." ▮

Vegan vs fish and meat

Nutrition /100g	**Vegan "salmon"**	**Atlantic salmon (wild, raw)**
Kilocalories	86	142
Sugars (g)	4.8	0
Fat (g)	4.4	6.3
Protein (g)	0.3	19.8
Fibre (g)	1.0	0
Salt (g)	0.7	0.1
Nutrition /100g	**Vegan "chicken" burger**	**Grilled chicken burger**
Kilocalories	502	438
Sugars (g)	5.7	4.6
Fat (g)	17.8	8.9
Protein (g)	23.7	35.8
Fibre (g)	4.7	3.1
Salt (g)	2.3	2.2

SOURCES: VEGEX, USDA, NANDOS

Helen Thomson is a consultant for *New Scientist* and author of *Unthinkable: An extraordinary journey through the world's strangest brains*

Space jam

More and more satellites are being crammed into Earth orbit, raising collision risks and spoiling our view of the heavens. Can we avert disaster, wonders **Robin George Andrews**

Straight lines across the sky like these are caused by the light reflected from satellites as they move

DEEPOL BY PLAINPICTURE/PAUL ZIZKA / TOP:SHUTTERSTOCK/PHONLAMAI PHOTO

ON 11 July 1979, shards of a space station fell to Earth. Skylab, the first US outpost in space, was supposed to plunge into the ocean 1300 kilometres off South Africa, but it took longer to disintegrate than predicted.

The 77-tonne behemoth overshot its target and exploded 16 kilometres above the Indian Ocean, sending debris into the water and across a 150-kilometre stretch of Western Australia. Thankfully, nobody was injured. But the incident served as a stark reminder that what we launch into space doesn't simply disappear.

Today, there are thousands of satellites in orbit, and the number is growing fast. The concern isn't only that one of these will land on someone's head. Certainly, our rush to fill space above Earth has significantly upped the odds of cataclysmic collisions in orbit that might rain stuff down on us. But space debris – defunct satellites, bits of rockets and fragments scattered by crashes – is only half of the problem. Satellites are unintentional mirrors, reflecting sunlight and obscuring our view of the stars. They are even making it harder to see threats coming our planet's way from outer space.

Many insist that when it comes to such problems, we are approaching a tipping point. "If something doesn't happen, we stand to lose the skies in three years," says Aparna Venkatesan, a cosmologist at the University of San Francisco, California. "The skies will change forever."

The pressure is on for something to change. There is no shortage of people seeking answers, but the big question is: can they be found and applied before it is too late?

We have been littering space for decades. In 1979, when Skylab plunged to Earth, it was one of just over 300 satellites in orbit. In mid 2019, there were roughly 2000 active satellites orbiting Earth. Today, there are more than twice as many as that – not forgetting all the retired satellites still up there.

The US government estimates that there are 23,000 pieces of debris larger than 10 centimetres in diameter in Earth's orbit, and more than half a million pieces smaller than that. Although you might think of it floating around gently, space debris is often moving at speeds in excess of 28,000 kilometres per hour. Moreover, it is hard to track. Whereas active satellites reveal their positions via on-board GPS, dead ones and all other debris can only be tracked by ground-based radar. The smaller stuff is sometimes invisible to such systems.

All of which means there will inevitably be collisions, which can be dangerous for active satellites and increase the chances of bits of debris falling to Earth and causing damage. In 2009, a derelict Russian military satellite slammed into an active one operated by Iridium Satellite LLC, a private US company. Both satellites were destroyed, causing some issues with Iridium's communications service and creating 1800 fragments.

Collisions could be avoided. The Space Surveillance Network, part of a branch of the US military called the Space Force, uses a global array of telescopes and radar systems to track objects and assess the likelihood of two crashing. If one or both are active satellites, another part of the Space Force lets the operators know so that action can be taken, usually by commanding the craft to fire thrusters.

But as low Earth orbit – between 160 and 1000 kilometres up – gets more crowded, this gets trickier. A major collision, perhaps one that will take out some vital satellite infrastructure, is already inevitable. But it could be much worse than that. If you have ever watched the 2013 film *Gravity*, then you have seen the so-called Kessler syndrome in action. This occurs when, beyond a critical threshold of objects in orbit, one collision's spray of debris causes many more collisions, creating an unstoppable cascade.

The problem is that these cascades unfold ›

SHUTTERSTOCK/YURIJ OMELCHENKO; JU JAE-YOUNG

very slowly and it could be centuries before major collisions are happening constantly, says Hugh Lewis, a space debris expert at the University of Southampton, UK. "We're looking out for some sign that this collision cascade has started," he says. "I think that all the evidence points to the fact that it already has. And it probably started decades ago."

If low Earth orbit gets crammed with satellites, and collisions turn that orbital highway into a shooting gallery, "then we've got the issue of trying to get through all this stuff to go to the moon", says John Crassidis, a space debris expert at the University of Buffalo. "Our astronauts are going to be in danger of being hit by this stuff."

One saving grace so far has been that space junk often gets dragged into the lower atmosphere and burns up. Unfortunately, as we have recently discovered, climate change means the rate at which this happens may decline, making orbital overcrowding worse.

In the upper atmosphere, the sun's extreme ultraviolet radiation splits molecular oxygen into two oxygen atoms that collide with carbon dioxide molecules, releasing infrared energy. Adding more carbon dioxide to the upper atmosphere increases this effect. As more infrared energy is released, it escapes into space and so the upper atmosphere cools. In this more frigid environment, the particles lose energy and the upper atmosphere contracts.

This phenomenon was predicted in 1989, and has been observed for some time. But Lewis and his colleagues recently realised it is influencing the lifetime of space junk. When falling orbital debris meets atmospheric particles, the object experiences drag. This causes the size of its orbit to shrink, bringing it closer to the denser, lower atmosphere in which it will eventually be incinerated. The climate change-induced contraction of the upper atmosphere will reduce the drag that debris experiences as it spirals toward us. This means it will stay in orbit for longer.

A recent paper, co-authored by Lewis, found that objects in low Earth orbit will stay up there for 30 per cent longer even if we restrict carbon dioxide emissions to successfully keep the global average temperature rise to 1.5°C this century. On current mitigation pledges, way more CO_2 is heading skyward and we are on track for 2.7°C of warming. This means the time junk stays up there will probably be even longer.

Asteroid watch

There are an estimated 25,000 asteroids 140 metres across or larger near Earth. But around 17,000 of them are missing. "We don't know where they are," says Megan Bruck Syal, a planetary defence researcher at the Lawrence Livermore National Laboratory in California. That is based on sound estimates of the number of such objects. The small ones could wipe out a city; the biggest would wipe out all life on the planet. It is vital they are found.

Astronomers are on the case. To look for potentially hazardous near-Earth objects (NEOs), telescopes are pointed toward the vicinity of the sun not long after sunset or a little before sunrise. During that time, telescopes are pointing in the direction that Earth is moving. That way, you can spot NEOs crossing in front of the planet's orbital path without being blinded by the sun.

Thanks to their positioning in the night sky, that's precisely when satellite constellations like those made by SpaceX are extremely well lit by the sun. City-killing asteroids are already hard to spot as it is. Now, says Syal, we may not be able to see them "because of this extra light pollution". This leads to an absurd possible future in which we miss an Earth-bound space rock because a private company wanted to sell internet access.

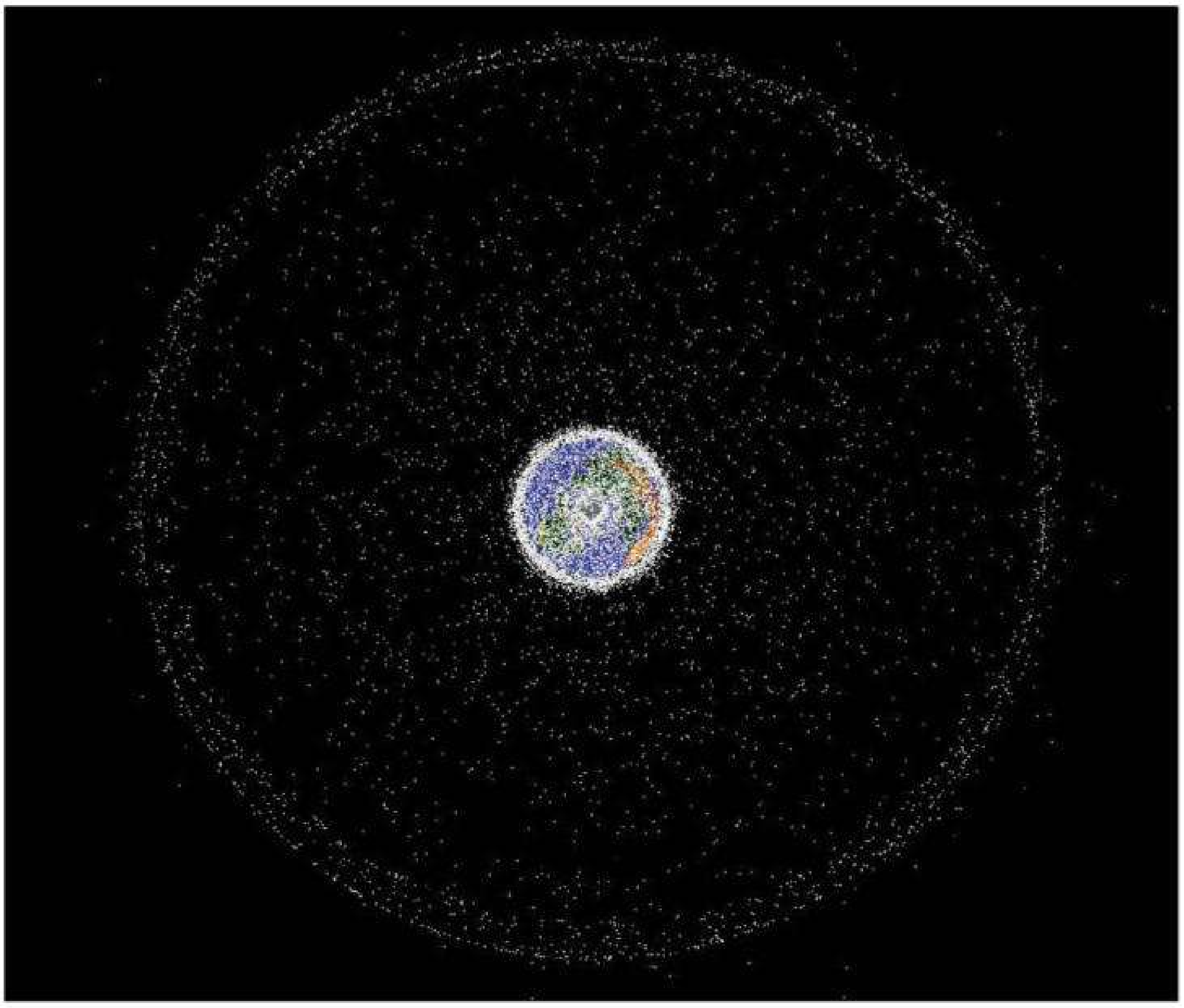
"You don't want to miss the one that's going to kill us all," says McDowell. "That would be embarrassing."

Out of space

As if all that doesn't sound bad enough, we have also found a different way to clutter space – one that has arguably more profound consequences for people back on Earth.

About a third of all the active satellites in space today belong to an internet-providing swarm named Starlink, owned and operated by SpaceX. Having multiple small satellites acting together or sharing orbital planes, known as constellations, isn't a new concept. But the sheer number of Starlink satellites led to a new word, the "megaconstellation".

The rationale for constellations that can cover a large proportion of Earth's surface might seem laudable. The European Union's Copernicus programme, for example, provides free information on marine pollution, deforestation, the movements of refugees, air quality and ice cap melting. California-based



NASA ODPO

Space derbis around Earth based on NASA data, as shown looking down on the north pole

company Planet offers similar services. Both aid an array of experts, from academics to emergency managers.

Starlink satellites are one way to get internet access to many remote communities that don't have it. "There's a lot of people in Northern Canada, particularly First Nations, who don't have good internet," says Sam Lawler, an astronomer at the University of Regina in Canada. "Starlink is going to be a huge, huge advantage for them."

The problem is megaconstellation satellites are so bright and so numerous that they threaten to diminish our view of the night sky. "These satellites, on average, are about a billion times brighter than the faintest things astronomers can see," says Connie Walker, an astronomer at NOIRLab, an umbrella organisation for several US-funded observatories.

Simulations show that with 65,000 satellites in the sky – a possible near-future scenario – this kind of light pollution would affect the entire planet. "The stars will still be there, but you'll be looking at them through a grid of moving satellites," says Lawler. Even in once-shadowed parts of the world, the Milky Way and meteor showers could eventually be washed out. Satellites could even obscure our efforts to watch out for incoming asteroids that could kill all life on the planet (see "Asteroid watch", page 44).

"Our astronauts are going to be in danger of being hit by this stuff"

The rush to space also has uncomfortable parallels with centuries of colonisation, where those with the least power suffered the most. Many Indigenous communities still use the night sky for traditions that are now under threat, such as for telling the time, for precipitating sociocultural or religious events and for wayfinding at sea. Even the potential benefits won't reach everyone, as costs are too high for many internet-starved nations. "We shouldn't have to choose between having astronomy and having the internet," says Lawler. Starlink didn't respond to a request for comment.

So how did we end up here, and what can we do about the growing downsides? The UN's Outer Space Treaty, humanity's first attempt at legislating for activity in orbit and beyond, says space is an open realm that anyone can use. But the treaty, which took force in 1967, didn't foresee the rise of private space companies or their constellations. Neither did individual nations. There are no internationally binding laws that apply to the operation of constellations. As long as satellites are doing what they are supposed to, governments can't interfere.

People are taking matters into their own hands. Various groups are experimenting with contraptions that remove debris from orbit. RemoveDEBRIS, a project led by researchers at the University of Surrey, UK, has successfully trialled the capture of debris using spacecraft armed with nets and harpoons. In August 2021, Japanese firm Astroscale managed to recapture a small satellite it launched into space using another craft armed with magnets.

None of these prototypes are trying to capture real debris yet. If they did, they might be pulled along by the momentum of such objects and become another sizable piece of space junk, says Crassidis. Moving between orbital altitudes to capture lots of debris would also require more fuel than these ›

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TOP: SHUTTERSTOCK/AAPSKY RIGHT: SHUTTERSTOCK/INGO BARTUSSEK

Satellite trails like these, captured during a meteor shower in Germany, are now a common feature in images of the night sky

> **“People are trying to survive, and so the skies aren’t on their mind”**

missions are currently capable of carrying.

Most experts agree that space junk must be regulated on an international level. One option is for different altitude ranges to belong exclusively to different nations and private companies, which would cut down on collisions in the first place. But, politically, an international body that deals with this is difficult to envisage at present.

The future impact of megaconstellations appears just as disheartening. Scientists have held two conferences discussing their impact on astronomy over the past two years, with no agreement on what is best to do. One thing is certain: megaconstellations are here to stay. “We have to accept that the landscape is changing,” says Jeffrey Hall, director of Lowell Observatory in Flagstaff, Arizona.

Software may eventually be capable of partially filtering out bright Starlink trails from telescope views, but this won’t be a panacea. Eventually, some astronomy done on Earth will move into space, out of the way. But doing that for all observations would be prohibitively expensive. It would also be bad for science “because for the same amount of money, we won’t be able to afford nearly as many telescopes”, says Jonathan McDowell, an astronomer at the Center for Astrophysics in Cambridge, Massachusetts.

Slow it down

Starlink has worked on dimming its constellation by painting the craft black and, during later launches, by adding a sun-blocking visor. But “there’s no way the companies can make the satellites faint enough to be invisible to research telescopes”, says Hall. And even if dimming efforts continue to bear fruit, the staggering number of satellites will always present a problem.

Some think confrontation may be a better option. “We’re not going to stop them, but we need to slow them down until we regroup grassroots community advocacy, in my opinion, that can partner with professional societies,” says Venkatesan. “And we slow them down through lawsuits.”

One legal challenge already in the works – based on an argument put forward by attorney Ramon Ryan – involves a law that requires agencies to assess if their future actions are going to cause environmental harm. Minor actions are exempt from this law. The Federal Communications Commission (FCC) – which approves the deployment of US-based commercial satellites – has applied this exception to almost everything it does. This means Starlink launches are exempt, while satellites launched by NASA – another federal agency – do require an environmental review.

Viasat, a Starlink competitor based in California, has launched a court action to try to halt the approval of 3000 Starlink satellites until after an environmental review is conducted. The case is currently working its way through the US Court of Appeals.

Optimistically, the US may one day adopt strict legal mandates on megaconstellations and space junk. But who is to say that China – gearing up for its own megaconstellation – will follow suit? And for the countries that do choose to legislate such actions in space, will the voices of their Indigenous peoples be heeded? History suggests not, but New Zealand provides a hopeful note in this regard. Every branch of the New Zealand government – including its space agency – has to consult the Indigenous Māori communities before doing anything.

The sky can be saved, but the solutions aren’t simple. They involve everyone, from all walks of life, and the hourglass is nearly empty. As the covid-19 pandemic has shown us, when a global crisis emerges, “it’s much harder to take action later—and much more expensive”, says Lewis. “You have to act when it looks like everything is fine.”

Venkatesan worries that a confluence of multiple crises – the pandemic, climate change, racial inequality, gender disparities, erosion of democracy – may hobble efforts to salvage the starry night. “People are trying to survive, and so the skies are not on their mind,” she says. “Who wants to read about another crisis?” ▮

Robin George Andrews is a freelance writer based in London, UK. For details on his latest book, see page 35

JENNIE EDWARDS

A new climate battle cry

We need more than peaceful protests in the fight against climate change, says Andreas Malm. He discusses his provocative new book with **Rowan Hooper**

WHAT is it about Sweden and climate campaigners? It has produced Greta Thunberg, of course, but also Andreas Malm, a writer and human ecologist at Lund University and a long-time climate activist. You might think of him as Greta turned up to 11. His controversial new book, *How to Blow Up a Pipeline: Learning to fight in a world on fire*, has a deliberately provocative title, but in it he makes the point that escalating environmental protests, from mass civil disobedience to property destruction and even sabotage, look necessary.

Rowan Hooper: Your book isn't a manual about how to literally go about destroying pipelines. Rather, it asks why climate activists don't use tactics of destruction. So why don't they?

Andreas Malm: It's a paradox. Just look at the most recent summer, which was truly a season in global hell with so many climate disasters one after the other. And still you don't see people taking out their frustration on the sources of their misery. And the paradox is also intensifying, given how much social unrest of other kinds you've seen in the world in recent years. Generally, the climate movement behaves in a very gentle and polite fashion. The International Energy Agency said just a few months ago that we cannot have any new installations in coal and oil and gas [if the world is to avoid more than 1.5°C of warming], and still that's going on without any mass backlash against it.

Most protest movements emphasise peaceful, non-violent resistance as the only way to overcome tyranny. Is that true?
No. I find it very hard to accept the reading of history that people from the leadership of Extinction Rebellion, for instance, have promoted – namely the idea that in past social struggles for progressive causes, those that have succeeded have steered clear of any kind of violence and only engaged in absolutely peaceful civil disobedience.

You can very easily find significant components of militant confrontation, ranging from the very obvious case of the abolition of slavery – which in the US happened through a very bloody civil war – to property destruction at the hands of the suffragettes, to rioting in the case of the poll tax in the UK.

It's peace-washing. Militant methods are written out of the history of these struggles. It's very difficult to make a well-founded, substantiated historical case for strategic pacifism. In the climate movement, we are facing an uphill battle. We are struggling against an extremely powerful enemy that has enormous material forces at its disposal, so why do we believe that the climate struggle could be victorious with less effort and less pressure than any of these previous struggles?

TOLGA AKMEN/AFP VIA GETTY IMAGES

Extinction Rebellion protesters blocked busy London streets in 2019

One worry is that if the climate movement starts on an illegal and destructive path, it would lose public support. Look at the UK – the protest group Insulate Britain has just been blocking roads, but people and politicians are very upset.
I feel torn about Insulate Britain. Obviously, I sympathise with its demands and with the idea that we need to disrupt business as usual. But the scenes where working-class mothers are begging these activists to get out of the way so they can go to their workplaces and put food on the table for their kids, not to mention the woman who was trying to get to the hospital, these scenes drive me crazy because these people aren't your enemy.

My wish would be for activist groups to do something to draw attention to their demands and disrupt business as usual, but not target working-class people. Imagine if Insulate Britain had instead gone after the ultra-rich – and we know they are the worst climate offenders – by, for instance, I don't know, setting off stink bombs in the richest neighbourhoods in London or throwing dung into the gardens of the rich or something like that. I'm just speculating here. But that would probably have drawn quite some attention. You need to develop a tactic that doesn't antagonise the people that you're supposed to help.

Doesn't destructive activism always risk alienating the public and the media though?
My argument isn't that we should go out and engage in indiscriminate disruption or property damage. The ideal is where you target fossil fuel infrastructure, not necessarily through property destruction. The bulk of it, perhaps all, would have to be through disobedience and mass action of the Ende

Gelände kind [the activist movement that began in Germany and occupies coal mines]. There, you have climate camps, with large groups of people congregating in a camp and then going to a fossil fuel installation and blocking it or entering it and shutting it down.

Last year, at the Ende Gelände camp in Germany, a group blocked a gas pipeline. And there was no massive outcry, no backlash. I think that if you go about this in an intelligent fashion, there is certainly a potential to win people's support for it, because I think that people generally are quite terrified by climate disasters and upset about continuous expansion of fossil fuel infrastructure.

You are very clear about opposing violence against people and about being very careful not to harm anyone. But isn't it a concern that this could escalate?

My point isn't that diversifying our tactics and stepping up in this fashion is a risk-free endeavour. It comes with risks that have to be dealt with somehow. My point is that we are so late in the day, and the mitigation of the climate crisis has been postponed for so long, that there is no risk-free option left anywhere. The way to deal with this risk when it comes to escalation would be, in my view, to have a very clear collective discipline about not taking up guns or engaging in any kind of violence against people.

We still need the fossil fuel companies. If activists start damaging their stuff, it isn't going to get them on side, is it?

It's clear after all of these years that business as usual isn't going to be broken without the threat of significant mass unrest. This isn't to say that we should just destroy the fossil fuel companies. It is to say that to overcome them and get them under control, to rein them in, you need to put a much greater degree of pressure on governments.

I'm in favour of nationalising private fossil fuel companies like BP or Shell or ExxonMobil and turning them into public entities for taking carbon dioxide out of the atmosphere so that they clean up the mess that they've created.

> "Business as usual won't be broken without the threat of significant mass unrest"

MARK KERRISON/IN PICTURES VIA GETTY IMAGES

Insulate Britain protesters obstructed access to UK motorways

What are your hopes for the COP26 climate summit in the UK?

The ideal scenario would be for COP26 to be an occasion to restart the climate movement of the global north [North America, Europe and Australasia] after its coma induced by the pandemic. Back in 2019, we were at the highest peak of mass mobilisation, and then we completely fell off a cliff when the pandemic broke out.

Are you personally hopeful for the future?

Not really. It's very difficult to be after a summer like we've just seen with all the climate disasters. But hope is the belief that things can be different.

There's nothing that makes it impossible for us to cope with this crisis and get out of it more or less intact as a species and civilisation. But the vested interests of keeping business as usual going are extremely strong, and they're still dominant. It is a question of the overwhelming power of the enemy, frankly, that is the fundamental reason for us to slip into moments of despair.

What is your message for people who might be thinking about taking part in climate activism?

Do engage in climate activism together with others. Think closely about what actions make sense, how you can tailor your interventions in a way that goes after the source of the problem without pissing off people in an unnecessary way. It is our only hope at the end of the day, I think.

I should stress that my book discusses property destruction as a possible avenue for escalation. But it doesn't say that that's what everyone has to do. It will inevitably, if it ever happens, be a radical flank that does it. If you're uncomfortable with that, do something completely peaceful – that's what I have done in my own life as a climate activist, and that's what I expect to continue to do. ▮

Rowan Hooper is *New Scientist*'s podcast editor and author of *How to Spend a Trillion Dollars*

GREEN AND ETHICAL checklist ☑

Commerce with a conscience – these environmentally-balanced businesses are run with strong principles, aiming to be good for the soul and the planet too

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The new Period Gift Box from Gift Wellness is filled with premium, practical and comforting products to help daughters navigate their menstrual journey with confidence. Plus 11 organic vegan cleansing bars for all the family.

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Enter here

checklists.co.uk/win/gift4

Save energy with eco-max

With energy prices rising up to 40%* and carbon emissions being high on everyone's list of priorities, both businesses and domestic households are looking for solutions to these problems.

Introducing eco-max by GWE. eco-max reduces the UK's high grid voltages supplied to your electrical equipment from an average of 242v down to the optimal 220v.

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Suitable for everything from homes and commercial properties through to industrial sites, eco-max can help everyone with their carbon reduction and energy cost reduction needs.

Maximise savings and carbon reduction with EV charging whilst protecting your chargers from over voltage and increasing life expectancy.

Contact the team to help you achieve net zero. Visit *gwenergy.co.uk* or call 01142 939935.

*Energy bills are rising – and what you can do about it (Ofgem, 2021).

Help the planet with The Cheeky Panda

If you're reading all the news about COP26 and wondering what you can do to help, there is a simple solution for you.

The Cheeky Panda don't believe in single-use plastics, purely because they're terrible for the planet. So, by purchasing The Cheeky Panda's super sustainable bamboo home essentials instead of the bog-standard choice, you're lessening your impact on this precious world.

Not only that, but for every pack you buy, The Cheeky Panda donate to their lovely partners at the World Land Trust, who will use that money to support the rainforest and all the growing green trees in it.

Buy bamboo, save trees, reduce plastic, help the planet.

Got it? Good.

Visit *uk.cheekypanda.com* to shop the full range and find out more.

Destination net zero – plan your roadmap and mitigate rising energy costs

Organisations can no longer ignore their responsibility when it comes to reducing energy use and tackling climate change. What's more, the scale and pace now need to be accelerated. But, armed with a wish list of energy efficiency measures, compounded by budget pressures, it can be difficult to prioritise the upgrades and plan for the transformation required.

Government funding schemes designed to reduce carbon emissions and support decarbonisation have made it possible for some organisations to make progress, although it is important to consider that many are unable to benefit and those that are should not rely on accessing finance from these highly oversubscribed and limited funds. Because of this, it is now essential that organisations prepare a strategic and realistic plan that keeps the UK on track to reaching net-zero targets.

The recent turbulence in the energy market, supported by the record high energy prices, has heightened the awareness of many to look towards reducing their energy consumption. After all, the cheapest kWh is the one you don't use. As a first step, investing in a simple energy audit will provide a comprehensive review of the energy used across your building portfolio, identifying a range of practical, low-cost and no-cost measures that typically pay for the audit within a year, along with a range of longer-term investment measures.

When combined with a Carbon Management Plan or Heat Decarbonisation Plan, organisations gain a full picture of their carbon footprint and their strategic plan to reduce it.

Better for you, better for the planet.

Others are considering options that allow them to reduce their reliance on the grid. The upfront cost of financing renewable energy projects has often prohibited implementation, but a growing number are recognising the value of a Power Purchase Agreement (PPA) to finance technology such as solar PV, helping them generate on site electricity, while reducing spend on imported energy.

zenergi.co.uk

Contact Zenergi at *bepositive@zenergi.co.uk* to understand more about energy audits, renewable generation and other measures to support your net-zero journey, and start reducing your energy use, carbon emissions and costs today.

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Are mushrooms a sustainable alternative to cut flowers?

Fat Fox Mushrooms offer a range of beautiful gourmet and medicinal mushroom growing kits that are easy, educational and bring a unique feature to your home. Lasting far longer than cut flowers, these alluring mushrooms are fascinating to watch and delicious to eat. They even produce carbon-rich compost for the garden. Using biodegradable packaging and sustainable growing mediums such as sawdust from furniture manufacture, Fat Fox create each kit by hand, bringing a personal touch to these beautiful edible delights.

Explore the wonders of mushrooms, visit *fatfoxmushrooms.com*

Fat Fox
Mushrooms

Peat free, waste free, and 100% sustainable soil improving mulch

Apsley Farms' mulch, made from rye and maize, is Soil Association approved for organic use.

This mulch has a low carbon footprint, as it is the bi-product of bio methane production from the anaerobic digestors on the farm, that heat over 8,000 homes a year.

Best of all, the mulch is vegan friendly, plastic and weed seed free and delivered in a large recyclable bag. Apsley Farms are a carbon neutral business, and they are aiming to go carbon negative in the next few years.

Apsley Farms offer a nationwide pallet delivery service with a delivery charge and a local service within 30 miles of the farm near Andover Hampshire.

The mulch costs £50 for 730 litres and can be ordered at *apsleyfarms.com* or by phone on 01264 554433.

APSLEY
FARMS

Unlocking UK innovation for green aviation

Airlines across the world are developing more efficient aircraft to meet customer demand and transition to net zero aviation.

TISICS, a leading innovator in decarbonising commercial aviation, are developing aircraft components that are designed to deliver up to 50% weight reduction on existing components and 70% on future aircraft designs.

On current aircraft fleets, an estimated 3.7 million tonnes of carbon dioxide emissions would be saved annually by applying this technology across landing gear alone.

TISICS secured a £2.9 million SBRI contract awarded through UK Research & Innovation and InnovateUK to prototype and test a full-size aircraft landing gear component. This UK Government contract for Project LightLand will allow TISICS to accelerate their growth and deliver the world's largest net-shape metal composite component, with double the stiffness of high-strength steel, at half the mass.

A privately owned SME, TISICS work in collaboration with UKRI, the UK Space Agency, European Space Agency and leading Industry Partners.

To find out more about TISICS' drive to accelerate zero-carbon transport visit the website at *tisics.co.uk*

TISICS
Metal Composites

Powering the charge to net zero

With COP26 right around the corner, world leaders are looking to make net zero a reality. Zenobē are accelerating the transition today by deploying battery storage in innovative ways for the transport and power sectors.

Tackling the challenges of switching diesel fleets to electric vehicles, Zenobē offer a fully financed turnkey solution. For a lower cost than running diesel fleets, operators get vehicles, charging, power, batteries and software. Today, Zenobē have over 25% share of the UK e-bus market, a goal of more than 3,000 e-buses by 2025 and global ambitions.

Zenobē's grid connected batteries deliver a more reliable, flexible and affordable power network. They help by smoothing peak prices and keeping the lights on while allowing more renewable energy onto the grid. The batteries store excess renewable power while it's being generated and release it back onto the grid when it's not. Aiming for 1GW of battery storage by 2025, Zenobē will help make a world without fossil fuels a reality.

Visit *zenobe.com/cop26* to find out how they are powering the charge to a net zero future.

ZENOBĒ
+ Rethinking energy -

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Clairefontaine

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Puzzles
Try our crossword, quick quiz and logic puzzle p53

***Almost* the last word**
Is it normal for rooks to bury bread instead of eating it? p54

Tom Gauld for *New Scientist*
A cartoonist's take on the world p55

Feedback
Why researchers are making honeybees crash into walls p56

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p56

Stargazing at home

Sniff out the dogs

Use Orion as a starting point to find its faithful companions, Canis Major and Canis Minor, says **Abigail Beall**

Abigail Beall is a feature editor at *New Scientist* and author of *The Art of Urban Astronomy*
@abbybeall

What you need

Clear, dark skies
Binoculars (optional)

IN NOVEMBER – at least in the part of the northern hemisphere I call home – the nights begin to get darker, the leaves turn all sorts of shades of orange and my dogs' paws seem to get muddier on every walk. But the one thing that really signals to me that winter is on its way is when Orion appears in the early evening sky.

Orion the hunter is an iconic part of the night sky. Stargazers anywhere in the world can find the constellation using the three stars in the asterism Orion's belt (pictured). But Orion can also be used to navigate to other parts of the sky. This week, in honour of my two dogs, Peanut and Jack, we will be using Orion to find two constellations named after dogs, Canis Major and Canis Minor. I like to imagine them running along faithfully behind Orion.

ALAN DYER/VW PICS/UNIVERSAL IMAGES GROUP/GETTY IMAGES

From the northern hemisphere, Orion appears with the red giant Betelgeuse above and left of the belt, and the blue star Rigel below to the right. The dog constellations are to the left of Orion from this orientation. In the southern hemisphere, Orion is the other way up and the dogs are to its right.

Let's start with Canis Major. This contains the brightest star in the night sky, Sirius. To find Sirius – which is actually a binary star system, not a single star – draw a line along Orion's belt. In the northern hemisphere, this line goes from right to left, and it is the opposite way in the south. Keep going until you come across a star that appears to twinkle brightly, and you have found Sirius.

All stars seem to twinkle because of the turbulence in Earth's atmosphere affecting the path of light reaching our eyes. Sirius is the clearest example of this effect. This is partly because it is so bright, but also because it appears low on the horizon in the northern hemisphere, so there is more of the atmosphere for its light to travel through.

Twinkly Sirius makes up the neck of the dog in Canis Major. To find the rest, look below Sirius in the northern hemisphere. You will find a triangle of three stars, which make up the dog's tail and the top of its back legs.

While Canis Major is quite clearly shaped like a dog, the constellation of Canis Minor requires a lot more imagination. The pattern is made up of two bright stars. To find Canis Minor, you need to use Betelgeuse, Rigel and Sirius. Imagine these stars make up three of the four corners of a parallelogram. Where you imagine the fourth would be, look around that part of the sky for a bright star. That's Procyon, and once you have it, you have found Canis Minor.

Like Sirius, Procyon is a binary star, comprised of a main sequence star orbited by a white dwarf. Procyon is the eighth brightest star in the night sky because it is quite close to us at only 11.5 light years away, although it isn't as bright as Sirius, which is "only" 8.6 light years away. ▮

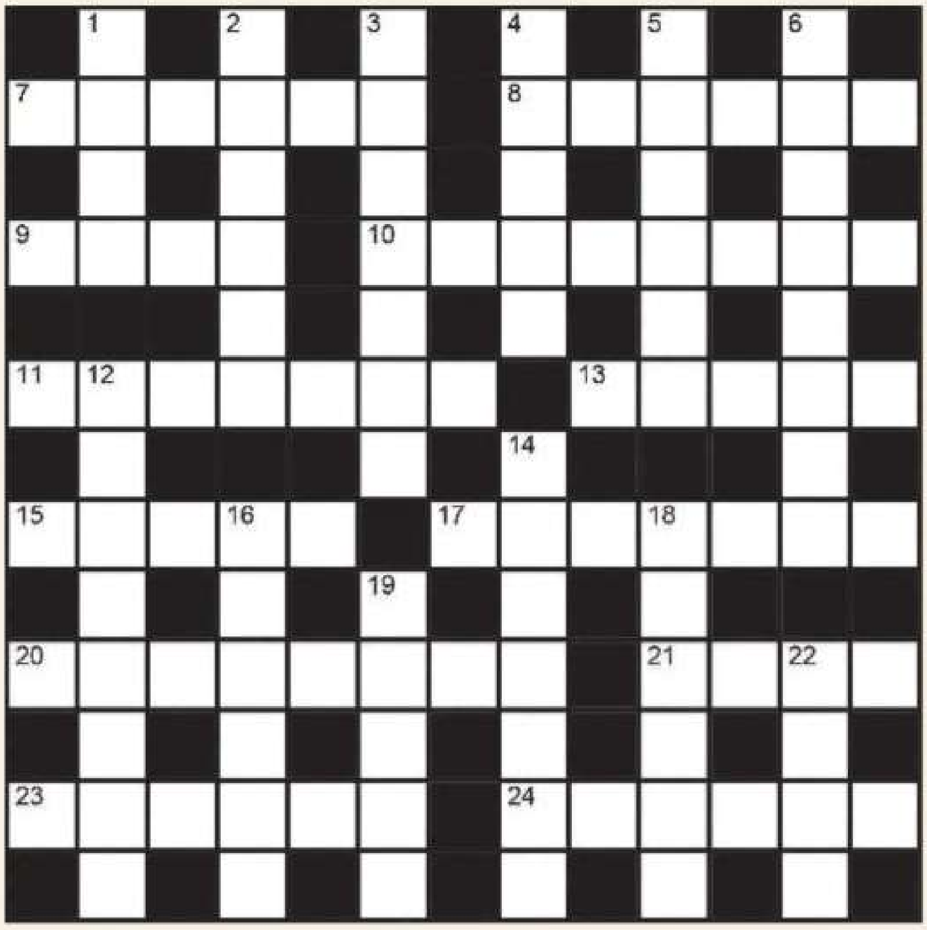
Stargazing at home appears every four weeks

Next week

Science of gardening

These articles are posted each week at newscientist.com/maker

Cryptic crossword #69 *Set by Wingding*



Scribble zone

Answers and the next quick crossword next week

ACROSS

7 Bad smell allowed to emanate originally from 6 (6)

8 High-flying student upset as Curie loses hope at last (6)

9 See 4 Down

10/15 Hot food news: he cooked 6 (3,2,3,5)

11 Soldier nearly flipped 6 (7)

13 Material owned by many Londoners (5)

15 See 10 Across

17 Setter repelled by minced lamb with solid preserves (7)

20 6 consists of bread after change (5,3)

21 Tech company's dropping the French programs (4)

23 Cold bone and tiny hair (6)

24 Tango with magician making sudden movement (6)

DOWN

1 Company in the region of cash crop (4)

2 Extremely tiresome to repeat name of tunneller (6)

3 Eek! Holy order creates narrow opening (7)

4/9A 6 that grows on some cats? (5,4)

5 Insect has the ability to go quickly (6)

6 Grow food (8)

12 Essence of basmati (some rice) having the same formula (8)

14 6 put head teacher in a euphoric state (7)

16 Bird makes unpleasant noise around centre of Gouda, Netherlands (6)

18 6 and jelly? Inspired combination for starters (6)

19 TV company and board game publisher make deadly weapon (1-4)

22 Agreement has power to do something (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #125

1 Which cells break down and absorb bone tissue?

2 How many digits are in Belphegor's prime?

3 What did Pierre-François Bouchard discover in 1799?

4 Which NASA probe, launched in 1989, mapped more than 90 per cent of the surface of Venus?

5 Which of these animals doesn't have the same name for its genus and its species: the common skunk, the Eurasian otter or the blue-footed booby?

Answers on page 55

Puzzle

set by Brian Hobbs

#137 Tricky treaty

SHUTTERSTOCK/AMAZEINDESIGN

As my four children sorted their Halloween candy, all was fun and games until James, my youngest, said to another child, "Look! I got one more piece than you!"

It was the shot heard around the kitchen table. As they all compared their loot, there was a clamour of children's voices:

"I've got two more pieces than you!"
"Hey! Why does she have three more than me?"
"At least I have four more pieces than you!"
"No fair! You've got five more than me!"
"Are you kidding?! You have six more than I do!"

I stopped this by seizing all the sweets and putting them into one big pile. I took three for myself (dad tax) and divided the rest evenly among the kids. Not everyone was happy about this, but that is parenting sometimes. Did James end up with more or less candy than he had at the beginning, and by how much?

Answer next week

JUERGEN FREUND/NATUREPL.COM

Why do most animals have five digits on their hands and feet, rather than another number?

This week's new questions

Why five? **Why do we and many other animals have five digits on each hand and foot? Why not some other number?** ***Bronwen Jones**, via email*

Double dipper **The constellations are pictures we perceive by "connecting the dots" of random stars, but it seems incredible that we have two dippers in the night sky with similar shapes and proportions. Is this just a coincidence or is there an explanation?** ***Donna Lindsey**, Hugo, Minnesota, US*

Rookie move

We recently saw a rook stuff three to four pieces of bread in its mouth, fly off and then bury them. Is this normal rook behaviour?

Andrew Taubman
Queens Park,
New South Wales, Australia

Almost every day, an Australian raven drops a hard crust of bread in our birdbath. It comes back after 20 minutes or so to retrieve and eat it, once soft. I am sure the rook described in the question – a fellow corvid – is doing a similar thing. No doubt the moisture in the earth softens the bread too.

David Stott
Macclesfield, Cheshire, UK

Many years ago, at work, we had a mobile service with coffee and toast for sale. My ground-floor office looked out onto a grassy area, and the kitchen was opposite. Every day, around 10.30 am, rooks would start to assemble on the roof above the kitchen. Then, as the coffee service finished, the servers would toss the unsold toast out of the window.

> "Rooks and other corvids are extremely clever, with intellectual abilities on a par with those of chimpanzees"

The rooks would swoop, grab a slice of toast, tear it into pieces and bury it. I never did see them return for the spoils, though.

Nicola Clayton
University of Cambridge, UK

Rooks and other corvids, such as crows and ravens, are extremely clever, with intellectual abilities on a par with those of chimpanzees.

What makes them different from other species of bird is that they can imagine the future and plan for it. They have self-control, too, and can think what they will benefit from later, compared with right now. This is one reason why they might bury bits of bread. It is common corvid behaviour to cache food, and one species, the California scrub jay, can act deceptively if another bird is watching it bury food and pretend to move its cache to a new place. What's more, it is only those birds that have been thieves in the past that do so, suggesting that it takes a thief to know one, and that the behaviour isn't hard wired or simply a product of learning through trial and error.

Corvids have a suite of other cognitive abilities. They are good at problem-solving and memory puzzles and they can even use tools. Rooks at a motorway service station in the UK have been observed using bin liners as a tool, cooperating in pairs to pull the liner up from rubbish bins in tandem in order to gain access to food – a process that takes at least 20 pulls. This is why I call corvids "minds with wings".

Magnetic influence

Do magnets have any effects on human cells?

Chris Daniel
Glan Conwy, Conwy, UK

The body is alive with electrical activity in the nerves and in the transport of ions between cells, and there can be measurable effects on the body when it is in the presence of a magnetic field. However, even strong magnetic fields don't appear to cause any adverse effects on health in the long term.

We are exposed to Earth's static magnetic field all the time, and we are affected by it. One experiment found that placing people in a chamber with a simulated version of Earth's magnetic field and then reversing the field caused changes in their brains' alpha waves. But there is little evidence that this affects behaviour.

The strength of Earth's magnetic field at the surface ranges from around 30 to 60 microtesla. The fields from household appliances and environmental sources, such as mobile phone masts and power lines, are typically around 1000th of the strength of Earth's magnetic field. There have been claims of health concerns connected to these fields, but so far these have proved inconclusive.

When the head is placed between the poles of a strong, alternating magnetic field, a glow is noticed in the peripheral vision, called magnetophosphenes. This is caused by stimulation of cells in the retina.

Weak, static magnetic fields and pulsed electromagnetic fields have been used to promote bone healing, as they appear to enhance the activity of cells associated with the production of bone and cartilage.

Transcranial magnetic stimulation of the brain is also used to provide evidence of changes due to conditions of the nervous system, such as multiple sclerosis and stroke, by exciting electrical activity in the nerve axons in the motor cortex.

Applied over a period of weeks, it can also be used to treat psychological conditions, such as depression and addiction. Unlike electrical stimulation, magnetic stimulation is painless and can be done without anaesthetic.

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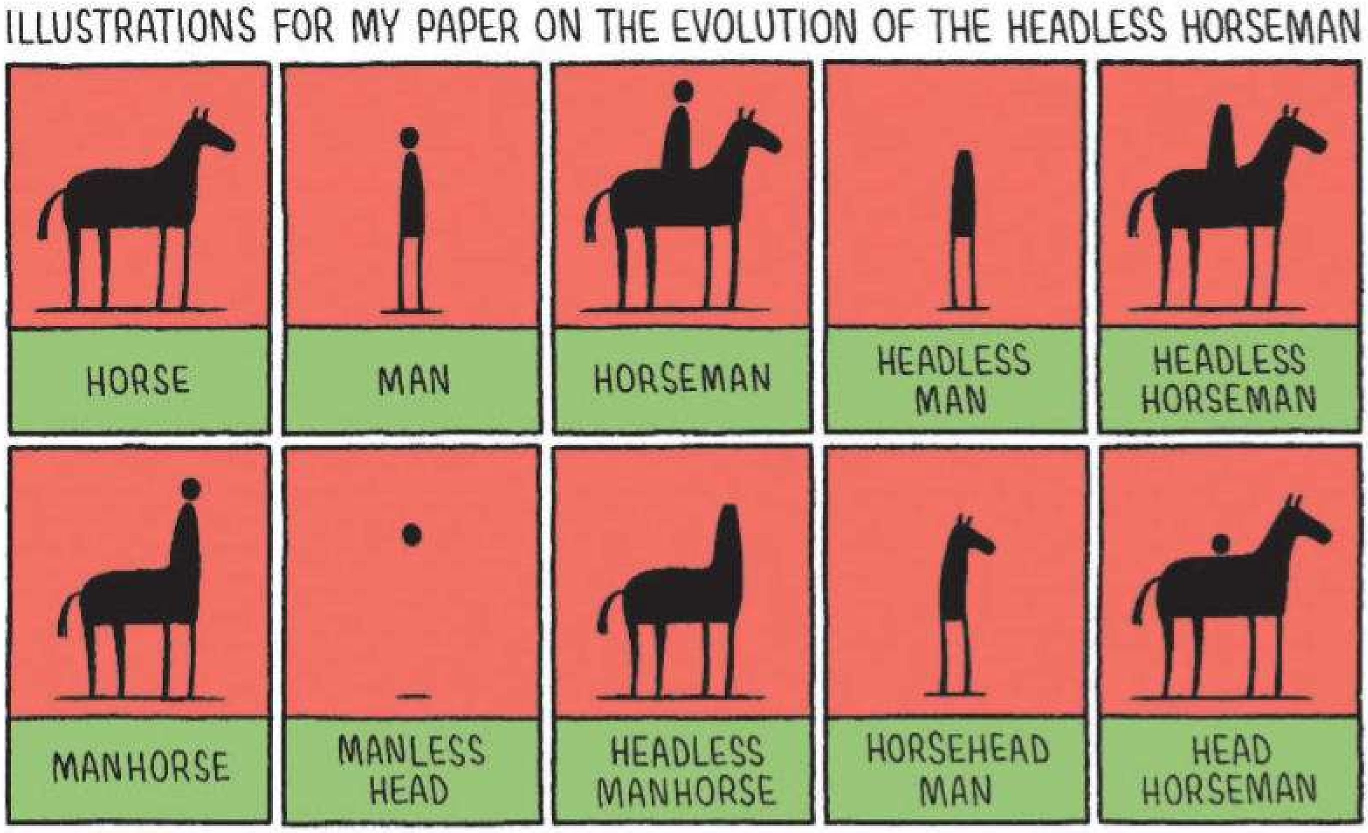
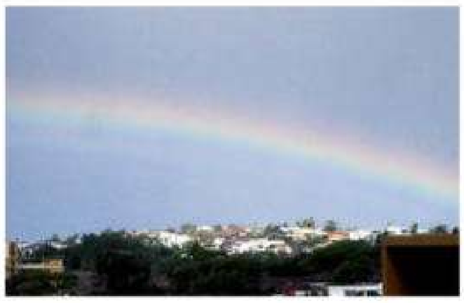
Tom Gauld
for New Scientist



A low bow

I saw a strange rainbow, at the wrong height compared with other ones I've observed from the same location with the sun close to the horizon. Under these conditions, it is supposedly impossible to see a rainbow at any other angle than around 42 degrees, but the arc of my "low bow" looked like 21 degrees. Can anyone explain? (continued)

Mike Follows
Sutton Coldfield,
West Midlands, UK
This low rainbow could be due to a temperature inversion. This is where warmer air sits on top of colder air at the surface, whereas air temperature normally falls as you ascend through the atmosphere. Light travels faster through warmer air, so instead of travelling in a straight line to the raindrops responsible for the rainbow, the light travels from a low sun on a curved trajectory, like an arrow. Sunlight enters the raindrops as if from a sun that is higher in the sky, resulting in a rainbow appearing lower than under normal conditions.



Ben MacGregor
Thurso, Highland, UK
I have seen an inverted rainbow produced by the reflection of the sun in a calm sea, even though I couldn't see the reflected sun.

The low bow will have been produced by an image of the sun that was much higher in the sky than the actual sun. This could have been produced by multiple reflections from surfaces such as open windows or solar panels.

Angus McKee
Glasgow, UK
Was this picture taken from a location with a significant patch of water? *[Ed: Yes, it was taken at Sydney's Northern Beaches, Australia]*

This can reflect the sun, causing another rainbow that looks like a mirror image of the part of the rainbow otherwise below the horizon. If the sun was low down, the normal rainbow would be high, whereas the rainbow from the reflected sun would be low.

Bill Tango
Manly, New South Wales, Australia
I recently saw a photo of a triple rainbow. The main rainbow was at the usual angle of 42°, and there was a fainter secondary bow at a somewhat larger angle. However, the third rainbow wasn't centred on the antisolar point (located opposite the sun from the observer's perspective) like the others and appeared below them.

The explanation was that the rainbows were seen over a body of water, and the third rainbow was caused by sunlight reflected off the surface of the water. Obviously, it requires a very special set of circumstances, including very calm conditions, to see such reflected rainbows. ▮

Answers

Quick quiz #125
Answers

1 Osteoclasts

2 31 – Belphegor's prime is 1000000000000066600000000000001

3 The Rosetta Stone

4 Magellan

5 The blue-footed booby, *Sula nebouxii*

Quick crossword #94 *Answers*

ACROSS 1 Pasteurisation, **9** Ozone, **10** Deoxidise, **11** Operation, **12** House, **13** Yttrium, **15** Inertia, **17** Titanic, **19** Laptops, **21** Evert, **23** Eye doctor, **25** Immunised, **26** Biome, **27** A Scanner Darkly

DOWN 1 Photosynthesis, **2** Slowest, **3** Elevation, **4** Radii, **5** Spoonbill, **6** Thigh, **7** Oviduct, **8** General surgery, **14** Michelson, **16** Euphorbia, **18** Thermos, **20** Outlook, **22** Tonka, **24** Elder

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#136 Narrowing the spectrum
Solution

The seven colours are red, orange, yellow, green, blue, indigo and violet. Of these, only red, green and indigo can be made from letters that occur in the names of the other colours. Of these three, red and green can be made from letters in the other two, so indigo must be Lise's favourite.

Just bee-hive!

We would like to be a busy-busy bee, being just as busy as a bee can be. Feedback often has reason to reflect on these words of wisdom from philosopher of life Arthur Askey as we see our rugby shirt-clad apian friends contentedly buzzing about their life-affirming business.

This is why we find the title of a paper recently posted to the bioRxiv preprint server by Julien Serres at Aix-Marseille University in France and his colleagues, "An innovative optical context to make honeybees crash repeatedly", particularly rude.

Still, far be it from us rosbifs to ever ask what has got into the French, even if it does involve training bees to fly along tunnels using sugary treats and then replacing various elements of the tunnel walls with mirrors to fool them into thinking it is twice as big, or even infinitely big, and seeing what happens.

The stated justification is to test a hypothesis that honeybees control altitude using visual information gleaned from the ground. What would Gill Perkins make of all this, we wonder (see page 27). How angry the bees were by the end of this process the researchers don't say. But given they discovered that a bee's visual field extends to 165 degrees, they should be wary of an angry buzzing coming their way.

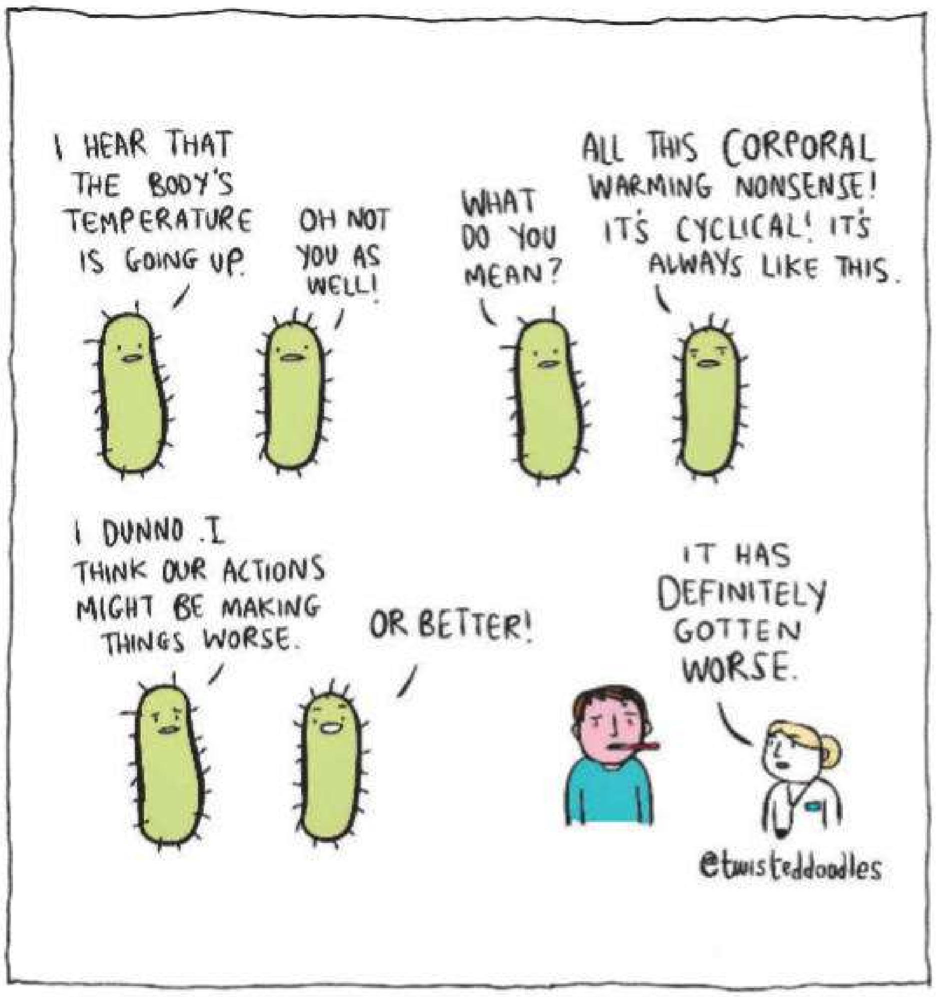
Messages to beyond

Geoscientist Marcia Bjornerud writes from Lawrence University in Wisconsin full of the joys of an email from scientific social networking site ResearchGate. It asks her to confirm whether James Hutton (1726-1797), the founder of modern geology, is her co-author. "Clicking Yes on a publication suggestion will send an email notification from ResearchGate to the relevant author notifying them about your suggestion," the message asserts, confidently.

We are somewhat unsettled by the implication that spam emails continue in the afterlife, an empty inbox being one of the things we are most looking forward to. Mind you, we didn't have to rootle too far down our relevant pile to find the case of a reader (5 December 2020) who received word from a similar site that he had been mentioned in a paper by the evolutionary biologist Jean-Baptiste Lamarck (1744-1829).

Our conclusion – that the spam emails indicate we are all already in the afterlife – is given angelic wings by a message forwarded by Fred Riley. It asks whether he is the Fred Riley who authored various papers such as the intriguing "Gate valve with nonplugging seat constructions" from 1932. "I've heard that I was a gifted child but writing a paper some decades before I was conceived is quite astonishing," he says. We notice too, Fred, that you were offered a "This Is Not Me" button to click. Dare you press it?

Twisteddoodles *for New Scientist*


I HEAR THAT THE BODY'S TEMPERATURE IS GOING UP.
OH NOT YOU AS WELL!
WHAT DO YOU MEAN?
ALL THIS CORPORAL WARMING NONSENSE! IT'S CYCLICAL! IT'S ALWAYS LIKE THIS.
I DUNNO. I THINK OUR ACTIONS MIGHT BE MAKING THINGS WORSE.
OR BETTER!
IT HAS DEFINITELY GOTTEN WORSE.
@twisteddoodles

Got a story for Feedback?

Send it to feedback@newscientist.com or New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT

Consideration of items sent in the post will be delayed

A difficult age

We are animated to open the floor on a related phenomenon by a message from Oliver Copeley-Williams. Asked recently to confirm his birth date on a National Health Service website in the UK, the options stretched back to 1850.

Oliver asks whether this indicates a perhaps inflated belief on behalf of the NHS in its ability to keep people alive – although, as he points out, the organisation didn't even exist in 1850. Perhaps it has invented time travel, but very wisely kept it quiet, he suggests.

We don't dare speculate, but as more and more of us grow old with the internet, we are glad the very oldest of us aren't being denied access to its services. Equally, we would welcome further competitive entries on the theme "how old the internet thinks people can be".

Imperial glory

Our recent discussions of the UK government's back-to-the-future embrace of imperial measures (25 September) has unleashed a cubic league of correspondence infused with the buccaneering spirit of the golden days when the country was last free.

Nigel Sinnott of Sunshine West in the UK's new no. 1 trade partner, Australia, points to astronomer Fred Hoyle writing to *The Times* in 1961 suggesting the country should prepare itself for "a population employing computers as normal articles of everyday life" by adopting base-8 counting.

Feedback is as bewildered as to why 100 isn't the new 64 as we are by Peter Waller of Bristol, UK, who recalls a boozy conversation about expressing the acceleration due to gravity in furlongs per square fortnight. "I will leave you to work out the actual number because my slide rule is in a box in the attic with my LP collection and a Chianti bottle lamp," he writes.

We aren't sure if that's a frisson or a shudder that passes through us at mention of the bottle lamp. Either way, we think it is about 71 billion at sea level, having both stimulated our mental faculties and thrown light on the problem by emptying a bottle of Chianti.

Futurescope

Meanwhile, Graham Roper shares a 2001 article from *Electronics Times* about a new British oscilloscope, "the first instrument of its kind to be calibrated directly in practical units of measure". With a screen area of 3 1/8 micro-acres, power consumption of 2052 British thermal units per hour and a maximum deflection of 21 1/11 milli-fathoms, its timebase had 24 calibrated sweep rates from 4 1/8 microfortnights/furlong to 208 1/4 fortnights/furlong.

We aren't sure, but the 1 April dateline may indicate humorous intent. We are so glad the joke's now on us. And that is quite, quite enough of silly units. ▮

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